POWER

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Education

NOTWITHSTANDING an occasional lament from one who has failed to find in education the equivalent of a meal ticket, the fact is too obvious to need iteration that the educated man will get more out of life in material as well as in mental satisfaction.

Without some degree of education one is eligible to only the irresponsible and less remunerative jobs and to less desirable associations.

Few in these days escape an elementary education. What are the opportunities for those who would go higher?

One who seeks learning because he wants to know will get it anyhow; by reading, by observation, by association with those who can talk the things in which he is interested.

They who seek to acquire knowledge as some do a trade, not because they have any particular love for or interest in it but because they think it will. "pay good money" need more direction and encouragement.

They remind me of the boy who got himself into a grind of compulsory and irksome violin practice, not because he had any love or talent for music but as the result of his attendance at a concert where a famous player, for a fabulous salary, submitted to the plaudits of an enthused audience.

Without a love of knowledge for its own sake, without the curiosity that keeps one's application intense and his interest in the next chapter keen, the pursuit is likely to become tedious, and hard work at it to flag.

This is the reason that so many who take up correspondence courses drop out before they have finished.

To one who cannot find the time and means to attend classes where study of his subjects may be shared with others, where there is the inspiration, encouragement and guidance of sympathetic instructors, the sustaining influence of class activity and emulation, the university extension and correspondence school courses afford excellent aids to home study and self-improvement.

The man who thinks he can buy an education or absorb it from a university atmosphere or by a subscription to a correspondence course without hours of hard work and intense application, or who thinks that a diploma or certificate of completion of such a course is a ticket for a reserved seat in the job line is riding for a fall.

But the one who has a real desire for knowledge and who acquires the study habit has means for its gratification and exercise at less cost and with more convenience and facilities than ever man has had before.

EDITORIALS

National Power Show Proves Worth

THE NINTH National Power Show is closed, and with the newly adopted plan there will not be another in New York City until December of 1932. Perhaps partly because of this, but certainly in consequence of the manufacturer's higher consciousness of his responsibility to business, this year's exhibition is outstanding.

People have been aware of a certain stimulation which has so pervaded and animated the show as to leave both exhibition and visitor with a definite satisfaction and sense of things accomplished.

Exhibits, including an unusual number of full-size machines in operation, were particularly well presented.

Attendance was splendid and, according to reports, responsive. Through all, the keen interest and questions of the visitors, pointing as they do to increased business activity, have inspired new hope and confidence.

The energy and foresight of the exhibitors have undoubtedly left a trail of inspiration the effect of which will be felt in the field of power production and beyond. *Power* congratulates them. As they have sown, so shall they reap.

Noted Engineer's Life Is Spared

LAST WEEK Prof. L. K. Ramzin, a Russian power engineer of international reputation, was sentenced to be shot, with four other engineers. All were accused of plotting the overthrow of the Soviet Government. Then came news that the death sentence has been commuted to ten years' imprisonment.

Newspapers of many countries have commented on this unique trial in which the accused delivered their confessions before the microphone for radio broadcast over the whole of Europe. Many questions have been raised concerning the conduct of the trial and the validity of the confessions. But, interesting as these matters are, it is not *Power's* intention to discuss the case from the political angle. Engineers here are primarily concerned with the fact that the life of a great engineer has been spared. The world can ill afford to lose the scientific contributions of such men.

Professor Ramzin, as head of the state Thermo-Technical Institute in Moscow, gained international recognition by his reports of research in the field of combustion, dealing particularly with pulverized coal and other finely divided fuels. In 1928 he delivered a paper at the London Fuel Conference. Many engineers will recall him as the author of two excellent papers on fuels at the Second International Conference on Bituminous Coals, held in Pittsburgh during the Fall of 1928.

Last June at the World Power Conference in Berlin three papers by Professor Ramzin appeared as outstanding contributions. One dealt with the combustion of peat, sawdust, rice husks, and brown coal in finely divided form, and reported that fuels forty per cent wet could be burned in suspension without the addition of other fuels. His paper on pulverized coal took issue with many beliefs commonly held in the field.

Professor Ramzin's most brilliant contribution to the conference was his paper on radiation in boiler furnaces. Proceeding logically from a mathematical analysis of experimental work, he proposed radical changes in boiler design for maximum utilization of radiant heat.

Too often in the past the world has been deprived of rare creative minds by wars and political events. The commutation of Professor Ramzin's death sentence raises the hope that the Soviet Union may eventually find a way to employ his technical abilities in those engineering services that benefit all peoples regardless of national boundaries or political beliefs.

Radiant Heat

MUCH has been written as to the nature of radiant energy from burning fuel. This energy is projected in straight lines in all directions, but may be absorbed by adjacent fuel particles, by the gaseous mixture in the furnace, or by water-cooled surfaces of the boiler. It has been shown to be a highly effective mode of heat transfer; hence con-

sideration is now given to the proper disposition of heat-absorbing surface to utilize radiant heat transfer to best advantage.

While these abstract ideas on radiant heat are generally accepted, authorities are by no means in agreement as to the laws governing its rate of emission and absorption in boiler furnaces. Highly technical articles on this subject have been published in this country and abroad and some interesting ideas have been contributed by papers and discussions at recent engineering meetings.

The difficulty seems to lie in the inability to determine what actually occurs in a flaming furnace and what are the effects of furnace gases at high temperatures on the transmission of radiant heat. Opinions differ as to the nature of the combustion process itself which is the source of the radiant energy. Dr. A. Schack's recent book in German has shed much light on radiant heat, particularly in the case of gases.

The need for further research and study is apparent, not only as to the combustion process itself but also to the reactions, interactions and effects that take place in the furnace. Turbulence in the furnace is known to have a highly beneficial effect on both boiler and furnace performance. Does turbulence provide uniform furnace temperature? Or does it merely displace cold gases by hot gases at the flame boundries? How can gas temperatures leaving the furnace be ascertained accurately? What laws actually govern radiant heat transfer? With all these problems solved, what is the best disposal of heat-absorbing surface between radiant and convection surfaces in steam generators?

These theoretical and practical problems concern every power engineer, and their early solution through further research is highly desirable.

Flexibility in Industrial Plants

THE DESIGN of power plants supplying both process steam and power to an industrial is generally based on estimated typical steam and power load curves. The ratio of steam to power and the pressure of the process steam dictate the operating boiler pressure, the heat balance arrangement and the type of prime mover; and the plant is designed to supply economically the dual services of power and steam in the proportions required.

In many industries, due to changing manufacturing methods or to changes in demand for certain products, the ratio of process steam to power, or the pressure of the process steam, may vary widely from the conditions for which the power plant was designed. Unless changes in heat balance can be easily made, extensive plant rearrangement may be necessary.

Much of the expense and work involved in rearranging the plant to meet variations in steam and power demands would be prevented if sufficient flexibility were incorporated in the original plant layout. Engineers should keep this in mind when designing power plants to serve industries whose processes are still in the development stage. But the cost of such flexibility should be carefully balanced against the probable loss in economy.

Another Improvement in Vertical Transportation

RECENT announcements that New York City's building code is to be changed to permit operating two elevators in one hoistway has raised wild assumptions in the minds of some newspaper writers. One expresses himself in the following burst of rhetoric: "The prospects of two or three elevators running up and down the same shaft, like monkeys on a stick, is especially terrifying. One hopes for high standards of sobriety on the part of the operators of these heavenly chariots." This is an example of the folly into which imagination may lead one on a subject about which he has little conception.

Automatic elevators in modern buildings are the safest means of transportation. Fatal accidents on such machines are practically unknown. Two elevator cars in the same hoistway can be made just as safe as one. They can be arranged so that it will be impossible to run the cars together even if safety devices fail. A control can be provided that will prevent operating the cars in opposite directions in the hoistway. When they are operating in the same direction the control will automatically keep the cars a predetermined distance apart.

There is an infinitely greater hazard when operating two express trains on the same track than two elevators in the same hoistway. Notwithstanding this, the public has no hesitancy about going to bed on a Pullman car while traveling sixty miles per hour, which is about four times as fast as suggested for modern elevator operation. To all outward appearances, these elevators will be the same as those that the public is now familiar with, and anyone looking for a "thrill" will be disappointed. The plan represents another engineering accomplishment in vertical transportation and not "monkeys on a stick."

▼

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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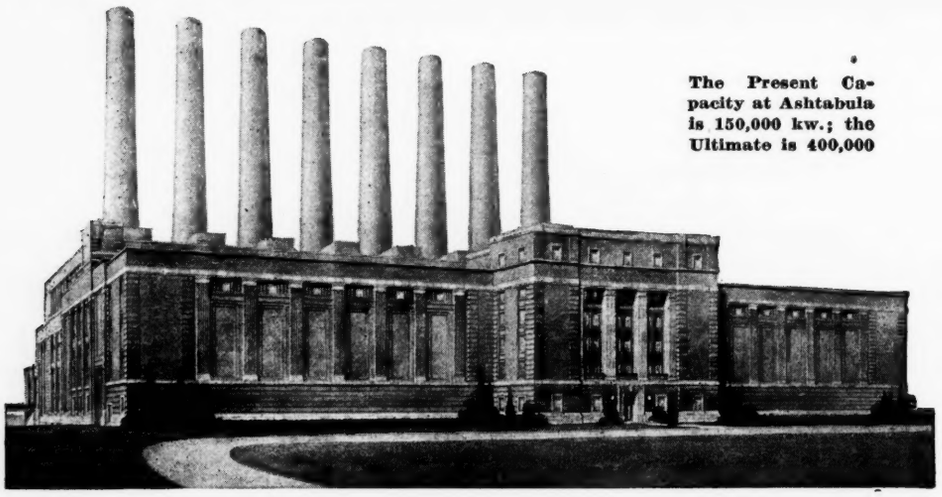


The Present Capacity at Ashtabula is 150,000 kw.; the Ultimate is 400,000

Cleveland Electric's ASHTABULA PLANT Reflects Avon's Simplicity

HEADING this page is an architect's drawing of a plant which might easily be mistaken for the Avon station of the Cleveland Electric Illuminating Company. Actually, it shows the new Ashtabula (Ohio) station of the same company. The resemblance is more than architectural. It extends throughout the design, and reflects the belief that more is to be gained by following a design that has proved satisfactory in service than by searching for something new.

Like Avon, Ashtabula is notable for the simplicity of its design. All frills are absent, and no attempt has been made to wring the last B.t.u. from the fuel by the extensive use of bleeder heating or heat-recovery devices. In fact, the Ashtabula plant bleeds at two points only for feed heating.

The throttle pressure and temperature of 375 lb. and 700 deg., respectively, are very moderate as steam conditions go in modern central stations. Yet the present capacity of this station is 150,000 kw., and the ultimate 400,000. The principal change from Avon is that the size of individual turbine units has been increased to 50,000 kilowatts.

The new station is located on Lake Erie, a short distance east of Ashtabula, which, in turn, is about fifty miles east of Cleveland. This station is near one end of the system of the Cleveland Electric Illuminating Company. At the western end is Avon station, twenty-three miles west of Cleveland.

Coal is brought directly to the plant by trunk lines connecting with coal field to the southward. Storage capacity of 224,000 tons is provided, the storage pile being served by a bridge crane. All coal-handling machinery is designed to handle 350 tons per hour.

The bin system of pulverized fuel is in use at Ashtabula, with a present mill-grinding capacity of 90 tons per hour. The pulverized coal is dried by blast air heaters, with a heater unit for each mill.

There are six 15-ton six-roll impact-type mills pulverizing to 65 per cent through 200 mesh. Pulverized coal is stored in 90-ton overhead bunkers (two per boiler).

Each boiler is equipped with sixteen slightly inclined vertical fan-tail burners, eight to a side. There are two primary-air fans for each boiler.

Each twin Stirling-type boiler has a common furnace fired from two opposite sides, built with air-cooled side walls and ash hoppers. The water screen has an effective heating surface of 980 sq.ft. Furnace volume above the screen is 32,560 cu.ft. Ash is removed through air-operated ash gates to a hydraulic sluiceway serving all boilers.

Of the eight boilers for which space is provided in the present installation, six have been installed. These are twin Stirling-type units, operating at 395 lb. gage pressure and 725 deg. steam temperature. Each boiler has 32,560 sq.ft. of water heating surface, 6,778 sq.ft. of superheating surface and 23,232 sq.ft. of economizer surface (in two units). At maximum capacity, 400 per cent rating, each boiler can produce 416,000 lb. of steam per hour, which is sufficient to maintain approximately 80 per cent load on one of the main generating units.

One induced-draft fan per boiler, supplemented by a reinforced tile concrete stack rising 246 ft. above the burner level, is driven by a 1500/300-hp. induction motor. Each stack will serve two boilers. Each boiler is served by an electrostatic dust precipitator having an

efficiency of 90 per cent at 250 per cent of boiler rating. The boilers are equipped with combustion control. Feed water is delivered to the economizers by four 1,500 gal.-per-minute 300-lb. centrifugal pumps driven by 600-hp. steam turbines.

The feed-heating system is extremely simple and designed primarily to afford reliability and ease of operation. From the condenser hotwell the water first passes to the generator air cooler, then to the condenser steam air ejector, thence through fifteenth and thirteenth stage bleeder heaters. From the thirteenth-stage heater the condensate is elevated to a small barometric heater condenser where it mixes with the exhaust from the plant steam-driven auxiliaries. Deaëration of make-up water is accomplished in the main condenser.

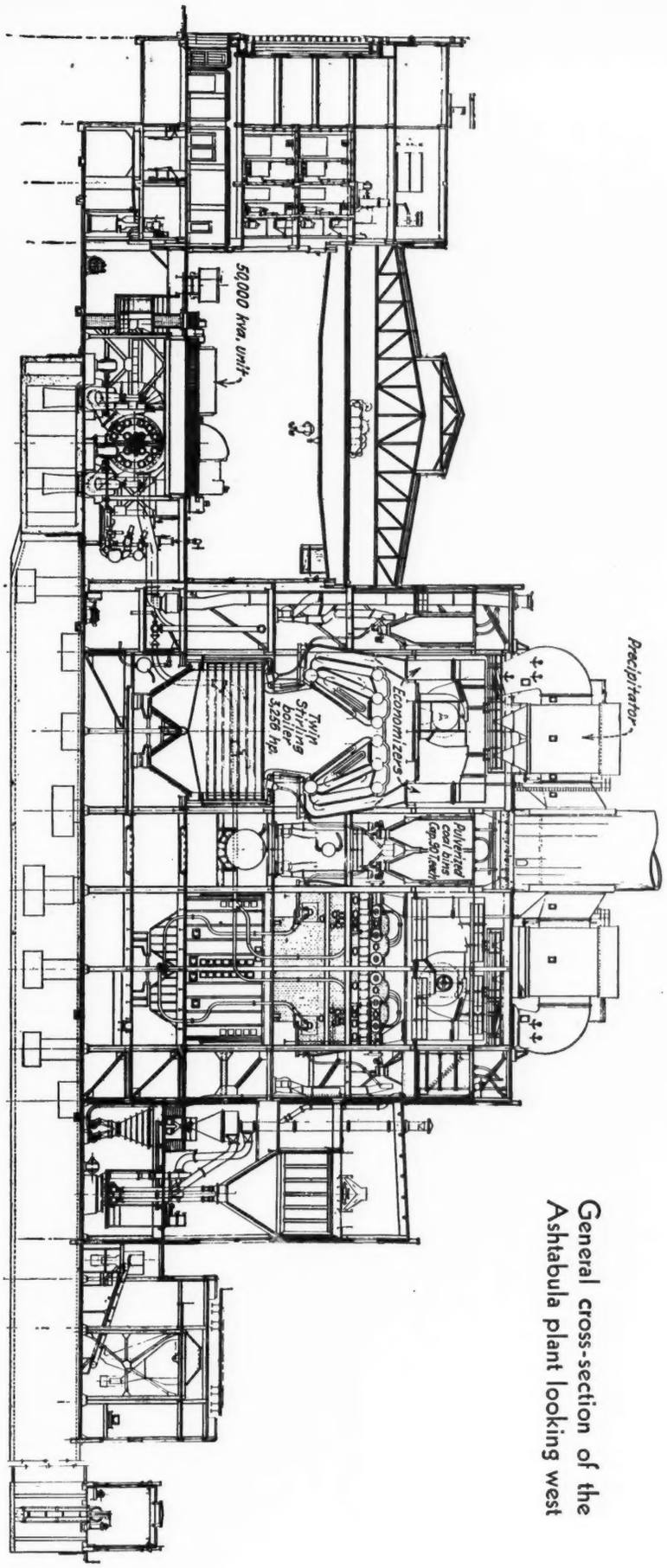
In the main turbine room are three 50,000-kw. units, with space already provided for a fourth unit. A traveling electric crane of 125 tons' capacity and a standard-gage railroad track extending the full length of the room provide excellent facilities for handling the large units. The three turbine-generators are installed with their shafts at right angles to the axis of the turbine room, steam ends toward the boiler house.

As already mentioned, steam is supplied to the turbine throttles at 375 lb. pressure and 700 to 725 deg. Each generator is equipped with an 18,000-sq.ft. air cooler and a totally inclosed ventilating system. High-pressure steam jets are inserted in the end bells of the generators for fire protection.

Each turbine exhausts into a 57,000-sq.ft. surface condenser, single-pass, rigidly connected to the turbine casing and spring-supported. Two condensate pumps and two circulating pumps serve each unit. These are normally motor-driven, but one pump of each type is equipped with dual steam turbine and motor drive. The circulating-water lines are fitted with 48-in. hydraulically operated gates arranged for remote control.

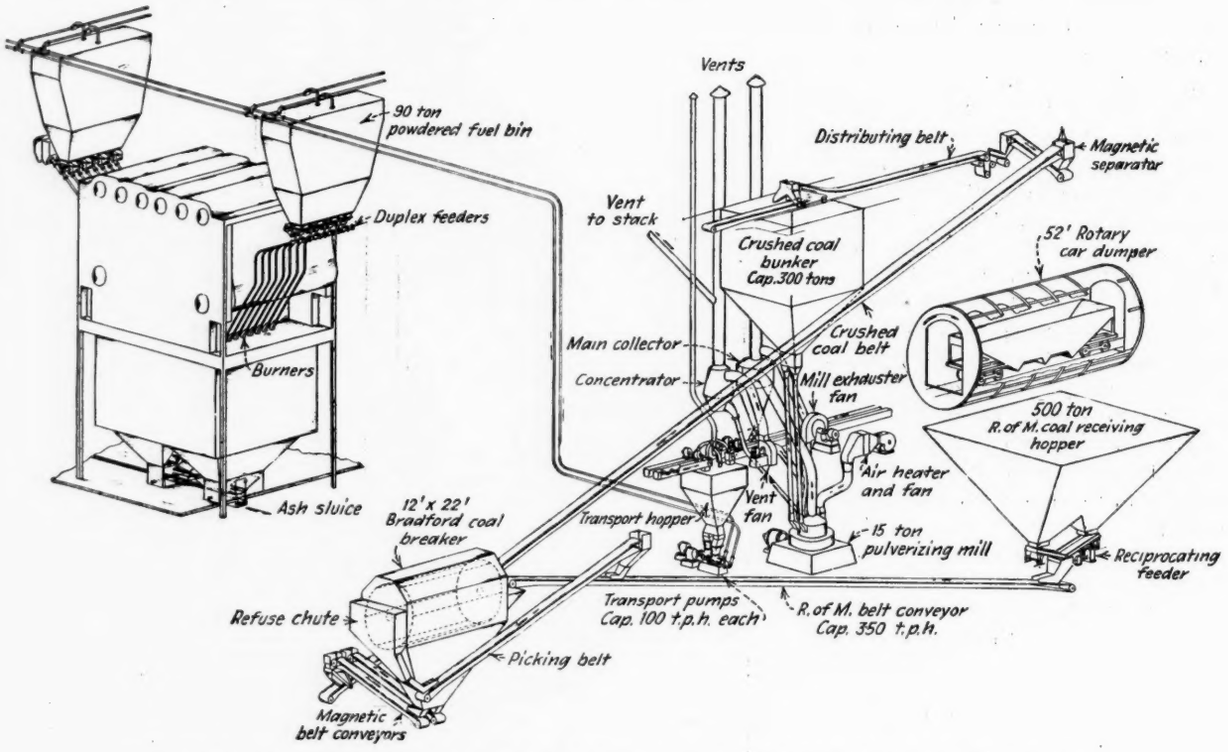
Ultimate full-load operation will require 1,008,000 gal. per minute of circulating water for each unit. The intake channel extends 1,500 ft. into Lake Erie, is 150 ft. wide and normally has a depth of 15 ft. at low water.

Circulating water is drawn to the condensers through a set of stationary trashracks into six 22-ft. revolving

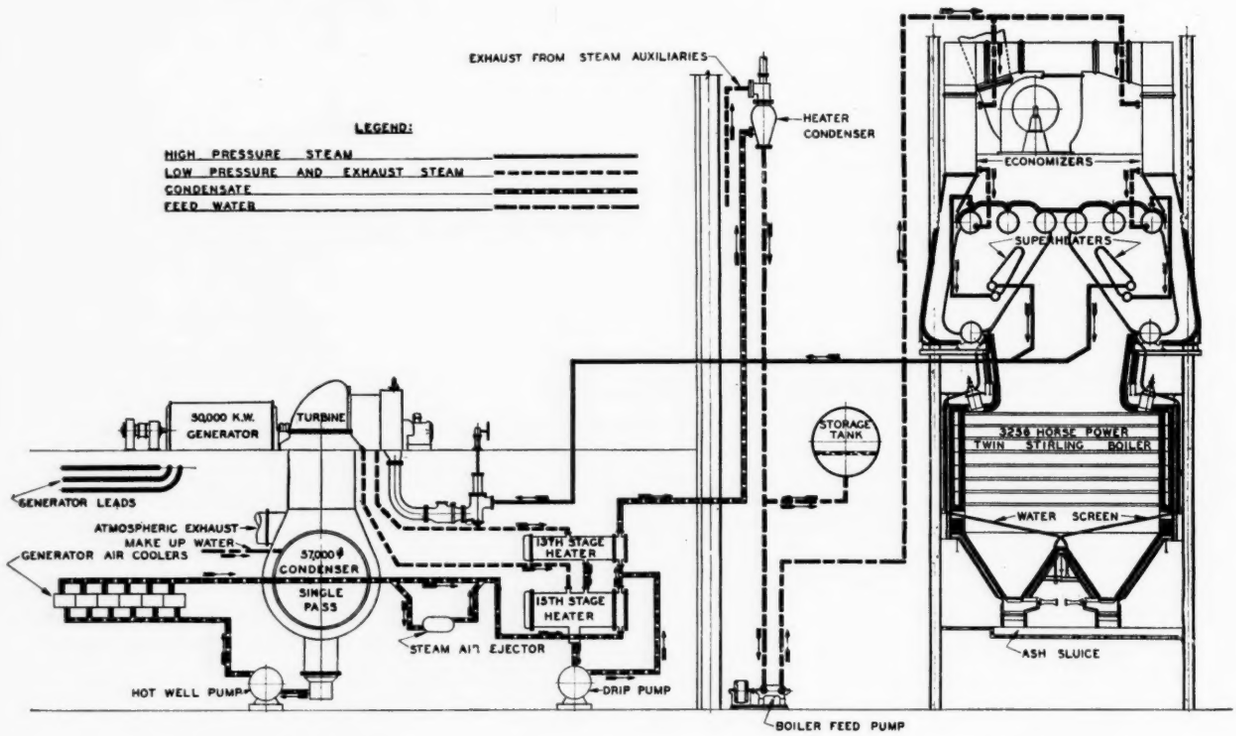


General cross-section of the Ashtabula plant looking west

Diagrams of Coal and Steam-Water Systems



Coal is brought directly to the plant by truck lines connecting with coal fields to the southward. Storage capacity of 224,000 tons served by a dredge crane is provided. All coal-handling equipment is designed to handle 350 tons per hour.



Six boilers and three main generating units have been installed. One stack serves two boilers. Each boiler is equipped with an electrostatic dust precipitator. Only two stages of bleed heating are employed. Steam is supplied to turbines at 375 lb. and 700 to 725 deg. All auxiliaries are normally motor-operated with the exception of one boiler-feed pump

List of Mechanical Equipment in Ashtabula Plant

Coal Storage and Handling

Storage capacity, normal, tons	224,000
Bridge crane, capacity 220 tons per hour,	Industrial Brownhoist Corp.
Rotary car dumper, 400 tons per hour	Wellman Eng. Co.
Car dumper hopper	Standard Scale & Supply Co.
Conveyor belts	Link-Belt Co.
Coal breaker	Heyl & Patterson

Pulverized-Fuel Equipment

Make	Combustion Eng. Corp.
Central system, present capacity tons per hour	90
Driers, 6 (1 per mill), heating surface each, sq.ft.	1,260
Mills, 6, 15-ton, 6-roll impact	Raymond
Conveyors, 4, screw, tons per hour each	60
Transport pumps, 2, tons per hour each	100
Bunkers per boiler	2
Capacity each bunker, tons	90

Steam-Generating Units

Boilers, 6, twin XXVI Stirling	Babcock & Wilcox Co.
Heating surface, sq.ft.	32,560
Steam conditions, 395 lb. pressure 725 deg. F.	
Soot blowers	Diamond Power Specialty Corp.
Convection superheaters, 2 per boiler, 6,778 sq.ft. total,	Babcock & Wilcox Co.
Location, between first and second tube banks.	
Economizers, 2 per boiler, steel tube, 11,616 sq.ft. each,	Foster Wheeler Corp.
Soot blowers	Diamond Power Specialty Corp.

Draft Equipment

Induced-draft fans, 1 per boiler	B. F. Sturtevant Co.
Capacity, at 15 in. static pressure, C.F.M.	327,000
Drive, 1,500/300-hp. two-speed induction motors,	General Electric Co.
Stacks, 3 (1 per 2 boilers)	Wiederholdt Construction Co.
Type, reinforced tile concrete, diameter 17.5 ft.; height, ft.	175
Size, ft.	17.5x175
Precipitators (Cottrell) 2 per stack	Combustion Eng. Corp.
Capacity, C.F.M. at 250 per cent rating	128,500

Furnaces

Furnace, air cooled suspension type, arch by	Detrick
Furnace volume, cu.ft.	32,560
Firebrick furnished by	Chas Taylor & Sons Co., Kier Firebrick Co., Cleveland Builders Supply & Brick Co.
Insulating brick furnished by	Armstrong Cork Co.
Refractory bond	J. A. Faulkner Co.
Constructed by	Rust Engineering Co.

Firing Equipment

Maker	Combustion Engr. Corp.
Type, vertical, two sides with pulverized fuel burners (fan-tail) per side	8
Primary-air fans, 2 per boiler, c.f.m. each at 20 in. static pressure	10,000
Secondary-air supply, hollow wall dampers	Bailey
Combustion control	Bailey Meter Co.
Water screens, 980 sq.ft.	Combustion Engr. Corp.
Ash hoppers	Allen-Sherman-Hoff Co.
Ash handling	Hydraulic Sluice

Pumps & Heaters

Feed pumps, four, 1,500 g.p.m.	Lecourtenay Co.
Turbine drive	Terry Steam Turbine Co.
Open heaters, 3, barometric jet condenser,	Worthington Pump & Mach. Corp.
Closed heaters 3, 1,925-sq.ft. and 3, 1,462-sq.ft.,	Griscom-Russell Co.
Drip pumps, 3	Lecourtenay Co.
Miscellaneous pumps	Lecourtenay Co.

Generating Units

Turbine-generators, 3, 50,000 kw.	General Electric Co.
Throttle conditions, 375 lb. gage, 700 deg. F.	
Generator air cooler, 18,000 sq.ft.	General Electric Co.

Condensing Equipment

Condensers, surface, 57,000 sq.ft., 1 per turbine,	Worthington Pump & Mach. Corp.
Tubes furnished by	Chase Brass and Copper Co.
Circulating pumps, 2 per condenser, 63,000 g.p.m.,	Worthington Pump & Mach. Corp.
Drive, 1 motor and 1 duplex.	
Condensate pumps, 2 per condenser,	Worthington Pump & Mach. Corp.
Drive, 1 motor, 1 duplex.	
Air pumps, 1 per condenser, steam jet.	
Intake screens, 6	Chain Belt Co.

Valves, Etc.

Boiler non-return	Foster Engineering Co.
Blowoff	Yarnall-Waring Co.
Hydraulic circulating	Chapman Valve Mfg. Co.
Strainers for house pumps	Elliott Co.
High-pressure gate	Chapman Valve Mfg. Co.
High-pressure globe	Edward Valve & Mfg. Co., Consolidated Ashcroft Hancock Co.
Standard gate and globe	Crane Co., Consolidated Ashcroft Hancock Co., Chapman Valve Mfg. Co., Lunkenheimer Co.
Reducing	Foster Engineering Co.
High-pressure traps	Armstrong Mach. Wks.
Low pressure traps	C. E. Squires Co.
Atmospheric relief	Cochrane Corp.
Boiler safety	Consolidated Ashcroft Hancock Co.
Throttle trip	Schutte & Koerting Co.

Miscellaneous

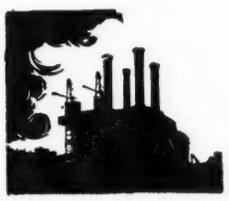
Piping	Pittsburg Piping & Equip. Co.
Pipe Covering	Johns-Manville Corp.
Cranes	Cleveland Crane & Engr. Co.
Elevators	Otis Elevator Co.
Recorders and Meters	Bailey Meter Co., Foxboro Co., Builders Iron Foundry
Thermometers	Taylor Instrument Co.'s
Master Clock System	International Time Recording Co.
General Contractor	Hunkin-Conkey Const. Co.
Steel	American Bridge Co.
Steel Erection	Bass Const. Co.
Marine Work	Great Lakes Dredge & Dock Co.

water screens and thence 425 ft. to the turbine room basement. After passing through the condensers the circulating water is returned to the lake through a discharge tunnel extending the length of the turbine room beneath the basement floor.

Main steam piping is so arranged that two boilers and one turbine-generator constitute a unit. The boilers of one group may serve the turbine of another group.

Seamless steel tubing, equipped with cast-steel valves and fittings and Van Stone flanges, is used for all high-pressure steam and water piping. Lines carrying high-temperature steam are insulated with 1½-in. high-temperature insulation and 2½ in. of sponge-felt covering.

All auxiliaries are normally motor operated, with the exception of the boiler feed pump. Additional security is provided through the installation of dual-driven condensate and circulating pumps and direct-current generator sets. Current for the electric auxiliaries is obtained from the main generators through station transformers. In general, motors above 40 hp. are supplied at 2,300 volts, exceptions being made for some of the coal-handling motors exposed to large quantities of dust and moisture. Other motors are supplied at 440 volts. Direct current for fuel feeder motors, switch-house ventilating fans and all elevators is obtained from motor-generator sets, two of which are dual-driven.



Selecting Boilers for Heating an Airplane Factory

Load curves showing the hourly quantities of heating steam required and consideration of future expansion formed the basis on which the boilers for heating the Curtiss-Robertson plant were selected

By BENJAMIN F. THOMAS, JR.
Consulting Engineer
St. Louis, Mo.

THE GROWTH of the airplane industry is well exemplified by the rapid expansion of the Curtiss-Robertson Airplane Manufacturing Company, located at Robertson, St. Louis County, Missouri, a few miles outside the city of St. Louis. This plant is a subsidiary of the Curtiss-Wright Corporation and manufactures light commercial ships. The original plant, completed about June 1, 1928, comprised a total floor area of 17,600 sq.ft. The plant on June 1, 1930, had a total floor space in the factory and service buildings of 139,550 sq.ft.

The heating of the entire plant is by unit heaters hung on the side walls or in the trusses. The only direct radiation is in the office building, in the wash rooms and locker rooms, and on the balcony in the assembly building, which is used for office space. The original installation of heaters and radiation amounted to about 7,000 sq.ft. of equivalent direct radiation. To supply steam, one firebox boiler, rated at 10,000 sq.ft. of radiation, was installed. Later, when two additional buildings were erected, the heating load was increased to about 20,400 sq.ft. and a 13,000-sq.ft. firebox boiler was added, bringing the total rated capacity of the boilers to 23,000 sq.ft. of equivalent direct radiation.

These boilers supplied steam to the heaters and radiators at 2 lb. pressure. The entire heating system is of the vacuum type and is connected to a pump that maintains a vacuum of about 2 pounds.

Extensions and additions to the buildings during the summer and fall of 1929 increased the heating load enormously. In addition to the new buildings, a paint spray room was built in one of the existing buildings. In this room the highly inflammable pyroxylene lacquers are sprayed upon the parts of the planes in booths equipped with exhaust fans. The latter removes 170,000 cu.ft. of air per minute when all of the booths are operating. Heat required for this room is out of all proportion to its size, the heat loss through the walls and roof being negligible. In extremely cold weather only 60 per cent of the air will be heated, it being the plan to curtail production during the few days when the temperature falls to or around zero. However, even with that reduction the heat required for the painting room amounts to 9,036,000 B.t.u. per hour.

Table I is a summary of the heating load for which the boiler plant was designed. It represents actual conditions last winter except for the heating system in the paint room, which will be installed this year. Further, consideration was given to two additional buildings, a hangar to the west, about 150 by 240 ft., and another assembly building to the east about 300 by 240 ft. Erection of these buildings seemed sufficiently certain at the time to plan the boiler room for them. It was decided to install enough capacity to include the hangar, and to lay out the boiler room so that another boiler could be added when the larger building was built. The total boiler load for design purposes was therefore 134,-

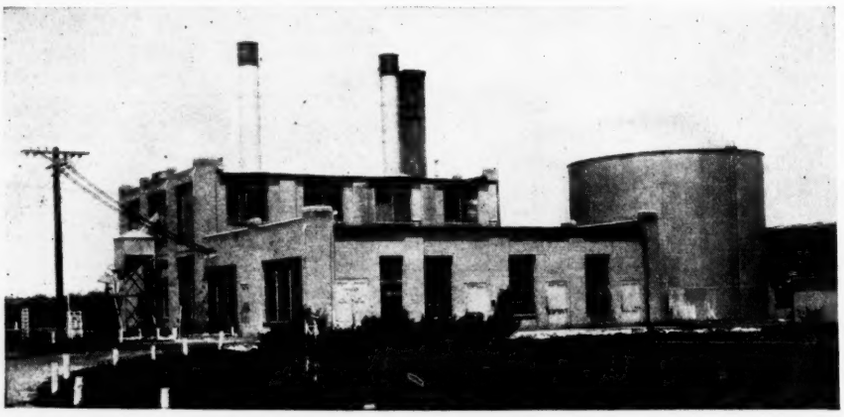


Fig. 1—Because the Curtis - Robertson plant is near a municipal airport the height of the stacks is limited to 50 ft.

000 sq.ft. of equivalent direct radiation, or 32,594 lb. of steam per hour.

To design the boilers and stokers properly a load curve, Fig. 2, was drawn for the plant based upon the average hourly temperature for each month of the year as determined for St. Louis by the United States Weather Bureau. While these temperatures are averaged for the twenty years ending in 1910, the Weather Bureau at St. Louis has said that there would be only slight, if any, difference for the average temperatures during the subsequent twenty years. An inspection of the curves shows that the seven heating months may be grouped into three general curves: one for December, January and February; one for March and November; and one for April and October. Load curves were worked up for these three groups.

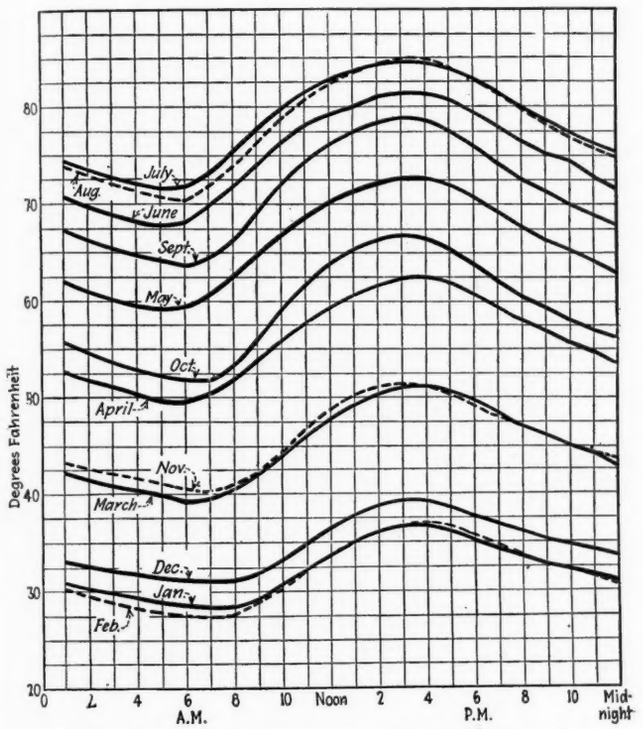


Fig. 2—Mean hourly temperatures St. Louis, Mo., averaged for the years 1890 to 1910

The heat loss for all of the buildings is figured for zero temperature outside and 70 deg. inside. If the outside temperature is only 35 deg. the heating requirements will be only half the maximum; so for each degree outside temperature, the heating load can be calculated by the ratio of the temperature to seventy degrees times the heat loss. Four load curves were figured and are shown on Fig. 3; one for the three severe months, one for March and November, one for October and April, and, finally, one for a typical cold day on which the temperature fell to 5 deg. above zero. This, however, is by no means the minimum temperature, which last winter was 20 below zero. As it has been the custom in the past to keep heat in all the buildings at all times, the load curves are shown for the full twenty-four hours.

TABLE I—SUMMARY OF HEAT REQUIREMENTS BY BUILDINGS

Building	Equivalent C. I. Radiation, Sq.Ft.	B.t.u. per hr. at 5 Lb. Pressure	Condensate, Lb. per hr.
Office building	1,500	360,000	360
Building D	4,455	1,069,000	1,114
Building DEX	3,840	954,300	987
Building E	7,435	1,784,000	1,854
Building G	7,040	1,688,500	1,749
Building I	41,600	9,993,200	10,000
Paint spray room	37,600	9,036,000	9,930
Total installed	102,970	24,884,800	25,094
Add 10 per cent for loss in pipes	10,300	2,488,500	2,500
Total	113,270	27,373,300	27,594
Proposed hangar	20,800	5,000,000	5,000
Total	134,070	32,373,300	32,594

The load curves show the estimated amount of coal to be burned per hour and the pounds of steam per hour at each load. The amount of coal was calculated by dividing the heat loss for each point on the temperature curve by 11,000, the assumed heat content of the coal to be burned and by 0.65, the assumed over-all efficiency of the boilers. The steam output curve was calculated by assuming that eight pounds of steam would be generated per pound of coal, which is sufficiently accurate for the purpose.

Having determined the maximum load and the approximate loading under various conditions of operation, it was necessary to decide upon the type and size of boilers. The load is entirely heating, all low-pressure, but a large part of the load is at a considerable distance from the boiler plant. About 42,000 sq.ft. of radiation is in the large assembly building, over 350 ft. from the boilers and over 500 ft. of equivalent pipe. This building is 300 ft. long and it is anticipated that another of the same size may be built beyond it.

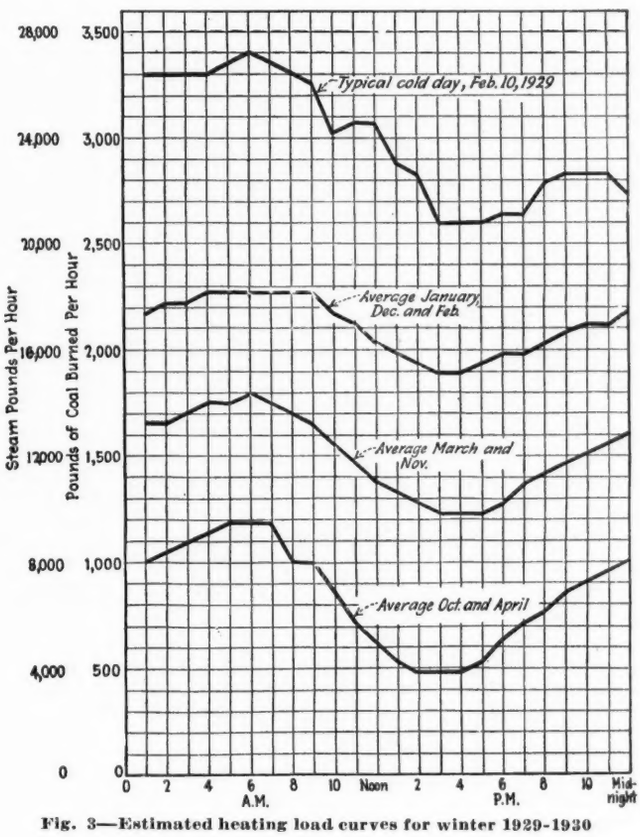


Fig. 3—Estimated heating load curves for winter 1929-1930

Three types of boilers were considered, the number and size depending upon the type: Three of the largest size of firebox boilers, rated at 33,000 sq.ft. of radiation each; three horizontal return-tubular boilers of 34,000 sq.ft. of radiation each; or two 40,700-sq.ft. water-tube boilers. The boilers were compared with respect to both normal and overload capacity, first cost, efficiency, upkeep, adaptability for stokers, and the operating pressure.

Capacity of the firebox boilers was considerably under

that of the other two types, because the rating on such boilers is nearly their maximum. Some overload could be secured from them, but probably not over 125 per cent of rating, so that if these boilers were installed, although they could take care of the present load, there would be no reserve capacity for future growth. The boilers considered were the largest that could be found of their type. The three return-tubular boilers, totaling 7,500 sq.ft. heating surface, were sufficient for the load, both present and prospective, but they could not be worked at such high ratings as water-tube boilers, and they necessitated a larger boiler room. The two 3,000-sq.ft. water-tube boilers seemed to fit into the scheme better than any other combination. They could be worked at 250 per cent of rating or better, if required, giving ample capacity for the present maximum load and considerable growth. Also, under normal conditions the load could be carried on one boiler, thus keeping the other for reserve and enabling proper maintenance on both.

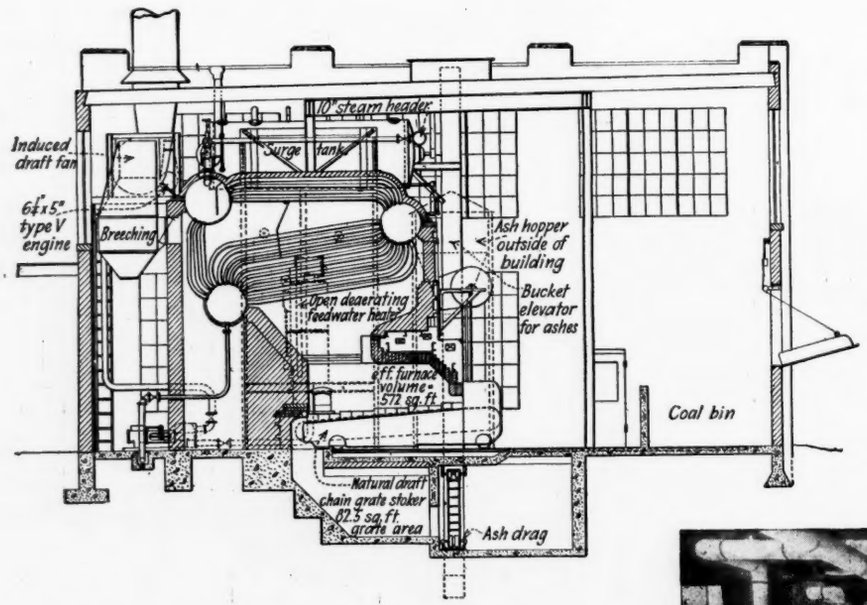


Fig. 4—Cross-section through boiler house shows arrangement of boiler and auxiliary equipment

Maximum working pressure that would be allowed with the firebox boilers was 30 lb. per square inch, whereas with either of the other two boilers pressures up to 150 lb. could be carried safely.

First cost of the three types of units was within 10 per cent, approximately, the water-tube boilers costing about 10 per cent more than the firebox. Their efficiency was slightly higher than either of the other two types. They required less floor space than the three horizontal-return-tubular or three firebox boilers; and they could be set for any type of stoker to burn the coal available. It was decided to install the water-tube boilers, designed for 160 lb. pressure and to be operated at 100 pounds.

With the higher pressure, the pipe line carrying steam to the buildings to the east could be reduced in size from 12 to 8 in., thereby saving considerable in the first cost of the line. Low-head, three-drum, bent-tube boilers, each having 3,077 sq.ft. of heating surface, were selected.

Natural-draft chain-grate stokers were decided upon after a study of their relative advantages. High-volatile, high-ash, free-burning coals from central Illinois, or "Inner Group" mines, are burned. The proximate analysis of the coals as received averages

Moisture, per cent	8
Volatile, per cent	39
Fixed carbon, per cent	40
Ash, per cent	13
B.t.u. as received	10,900

The stokers were designed with 82.5 sq.ft. of effective grate area, to burn 40 lb. of coal per hour per square foot of grate area when the boilers are operating at 225 per cent of rating. The boilers were set 11 ft. above the floor line to the center of the mud drum, which gives a minimum flame travel of 9 ft. and an effective furnace volume of 572 cu.ft. With these proportions, smokeless operation of the plant is expected. The stokers are driven from a lineshaft across the face of the boilers. This lineshaft may be driven either from a 4x4-in. vertical steam engine set on the floor alongside of one boiler or from a 3-hp. back-geared electric motor set on a platform between the boilers. The engine and the motor are connected to the shaft through jaw clutches, and either one is capable of driving both stokers simultaneously. The engine will be used for normal operation, exhaust steam being employed to heat feed water. The motor will be used for starting up when the boilers are cold, for turning the stokers for repair work and emergencies.

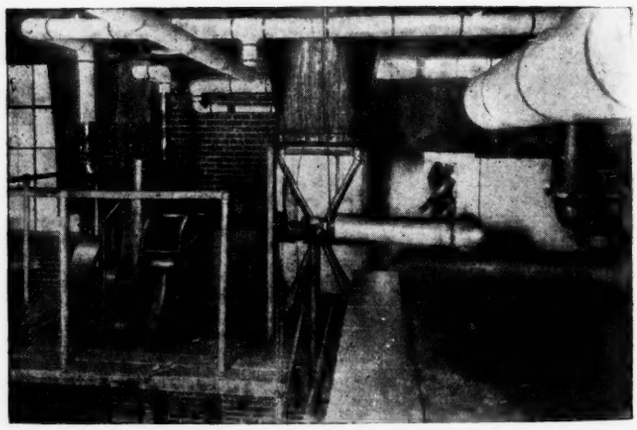


Fig. 5—Engine-driven induced-draft fans were installed because neighboring airport restricted chimney height

The boiler plant is on the north side of the St. Louis municipal airport, on city-owned property, and one of the provisions of the lease limits the height of buildings to 30 ft. above the ground. But special permission was secured to build the stacks to a height 50 ft. above the ground. This limited chimney height made necessary the installation of an induced-draft system.

Fans and engine drives are mounted on platforms built behind each boiler. Two fans were installed, arranged with an interconnecting breeching so that either may be used for either boiler. Each fan has a capacity of 22,000 cu.ft. per minute at 2 in. static pressure, sufficient to carry the boilers at 250 per cent rating. They

Principal Equipment in the Boiler Room

Boilers, 2, water-tube, three-drum, bent-tube, 3,077 sq.ft. heating surface, 100 lb. pressure, effective furnace volume 572 cu.ft., Babcock & Wilcox Co.
Stokers, 2, natural-draft chain-grate, 82.5 sq.ft. grate area, 11 ft. 11 in. long, 7 ft. wide, driven by 4x4-in. Wachs engine or 3-hp. back-geared motor.....Laclede Stoker Co.
Feed-water regulators, 2.....Swartwout Co.
Safety valves, 2 per boiler, 4½ in. dia.....Crane Co.
Non-return valves .....Edward Valve & Mfg. Co.
Blowoff valves .....Yarnall-Waring Co.
Soot blowers, 4 heads per boiler.....Vulcan Soot Cleaner Co.
Water column, high and low alarm...Reliance Gauge Column Co.
Ash handling, elevator, ash drag and storage bin, Stephens-Adamson Mfg. Co.
Induced-draft fans, 2, each 22,000 c.f.m. at 20 in. static pressure, 650 deg. F., driven by 6¼x5-in. engine through Texrope drive .....Clarage Fan Co.
Damper regulators.....Ruggles-Klingemann Mfg. Co.
Feed-water heater, 50,000 lb. per hour capacity, direct-contact aërating .....Cochrane Corp.
Boiler feed pumps, 2, duplex, 10x6x10 in..Lima Pump & Supply Co.
Boiler feed pump governors, 2, excess-pressure regulators, Swartwout Co.
Back-pressure valve, 6-in. multiport.....Cochrane Corp.
Pressure-reducing valves .....Boylston Steam Specialty Co.
Steam traps, high-pressure.....Strong Carlisle & Hammond Co.
Steam traps, low-pressure.....Warren Webster & Co.
Fabricated piping.....Geo. B. Limbert & Co.
Heat insulation .....Johns-Manville Corp.

are driven by 6¼x5-in. vertical engines through Texrope drives. Engines were selected instead of motors because of the absolute dependence of the plant upon the induced draft, and the long electric transmission lines feeding the factory sometimes fail. In addition, exhaust steam from the engines could be used for heating the feed water. The fan assembly and part of the breeching are shown in Fig. 5.

The two original firebox boilers were left in place temporarily, but it is planned that when additional boiler capacity is needed they will be dismantled and a new high-pressure boiler installed in their place. The boilers supply steam at 15 lb. pressure into the piping system that feeds the original group of buildings, and the returns from these buildings are collected by the vacuum pump, located in the old boiler room, and fed back into the two boilers. The new boilers generate steam at 100 lb. pressure and feed it through a long pipe line to the new assembly building and to the paint spray room. At each of these points pressure-reducing valves lower the pressure to 5 lb. for the heaters. To supply the older buildings the high-pressure line was connected through reducing valves to the header over the firebox boilers, and to supply low-pressure steam into the high-pressure line (which may be desired in the summer time when one of the small boilers will supply enough steam to the paint spray room to reduce the humidity) a valve was placed between the low-pressure header and the high-pressure line.

Condensate from the heaters in the assembly building is collected by a vacuum pump located in the building. This pump discharges through a 4-in. line into a 5-ft. diameter 16-ft. long surge tank, into which the original vacuum pump also discharges. This tank is vented to the air and overflows to the sewer. The county water supply is connected to the tank through a float valve so that the water level will not fall below a two-foot depth. From the tank the water flows by gravity into a deaërating feed water heater, and then into the boiler feed pumps. These pumps are 10x6x10-in. duplex units each capable of supplying both boilers when operated at 225 per cent of rating.

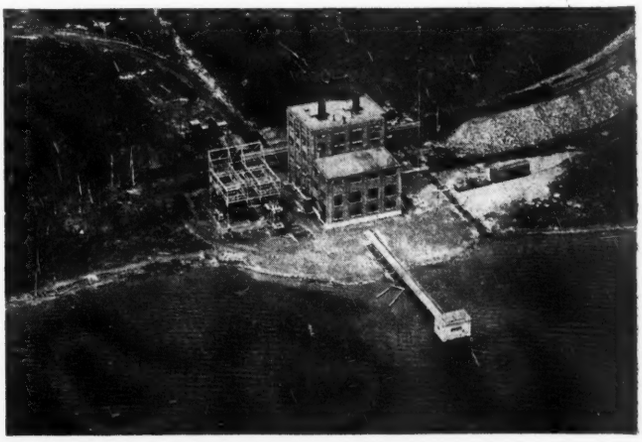
The design was started on Sept. 10, 1929, and all the work was completed and the plant in operation on March 31, 1930. One boiler was placed in operation on Jan. 16, 1930, which was fortunate, for two days later the temperature fell to 20 deg. below zero. By Feb. 18 the pumps, feed-water heater and regulating equipment were installed and operating.

Mine-Mouth Plant Completed For Dominion Coal Co.

THERE has recently been completed for the Dominion Coal Company, at Glace Bay, Nova Scotia, a new plant called the Seaboard station. The site is on a salt water inlet, near the coal company's No. 24 mine. Thus there is provided an ideal combination of unlimited condensing water and a fuel supply with no transportation other than the mine cars. The outdoor transformer and switching station makes connection with the outgoing high-tension transmission line, connecting the plant with the loop system, which ties together the six power stations supplying the Glace Bay, Sydney, Sydney mines, and the North Sydney steel and coal properties.

The present installation comprises two 9,219-sq.ft. Stirling-type pulverized-coal-fired boilers, generating steam at 450 lb., 650 deg., and one 7,500-kva. turbine-generator. Provision has been made in the coal- and ash-handling equipment, and in the condensing water tunnels, for a plant three times the present capacity.

The furnaces are water-cooled on the entire front wall, the rear wall from ash hopper to mud drum, and the side walls up to a point on a line with the center of



Aerial view of the Dominion Coal Company's Seaboard station

the drum. Also there is a water screen on the bottom. The remainder of the side walls and the rear wall, above the mud drum, are of solid refractory.

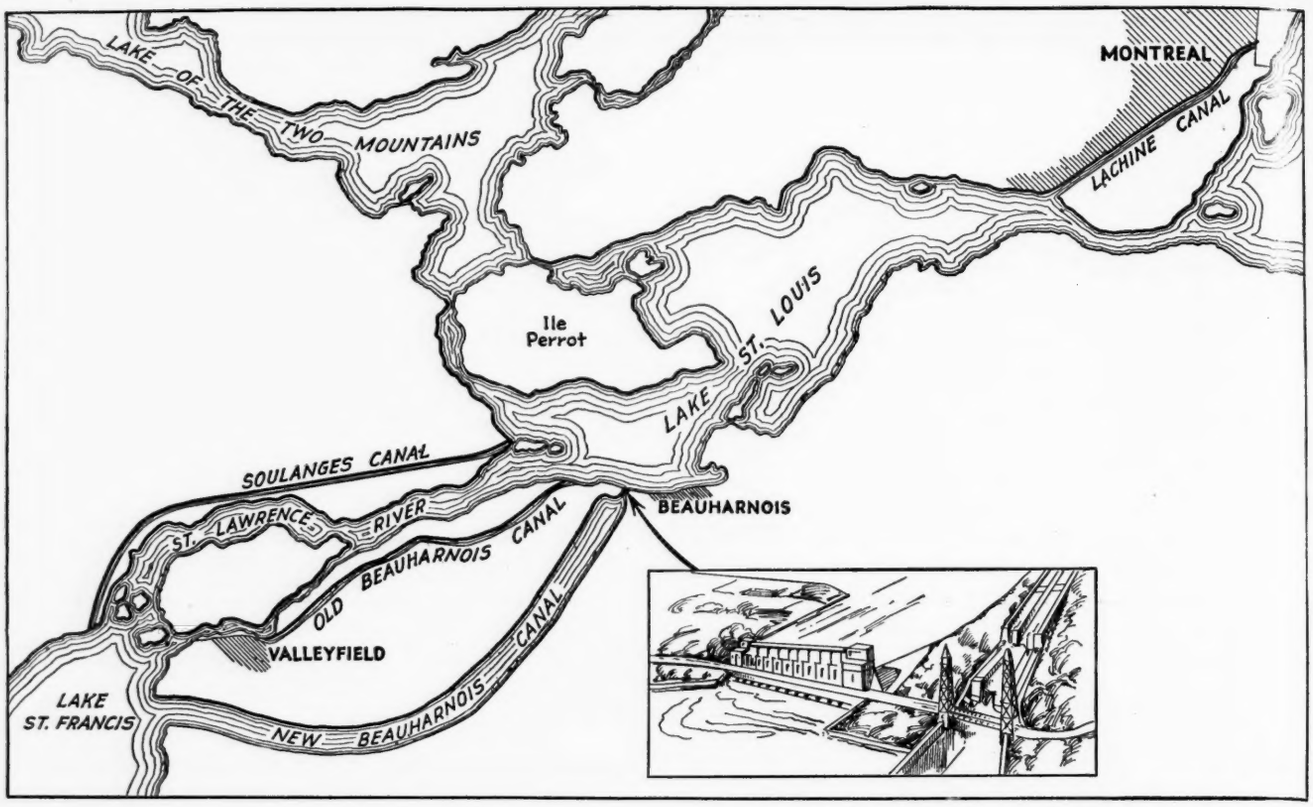
Steam is extracted from two points in the turbine for feed-water heating, the pressure range of the lower extraction point being 5 to 12 lb. abs. and the high pressure point 47 to 118 lb. abs. The single-effect submerged-type evaporator is employed to supply distilled water for boiler feed make-up.

The intake well and screen house are located in the bay, about 200 ft. from the building. This was necessary because of the shallow water and in order to minimize ice troubles in winter.

The screen house building is designed to contain two traveling water screens, capable of handling sufficient condensing water for 2,500 kw. capacity. A temporary installation of three tiers of stationary screens has been provided for the present unit.

All motors for station auxiliaries are of the squirrel-cage, linestart induction type and are equipped with either ball or roller bearings.

The new station was designed and built by the United Engineers & Constructors of Canada, Ltd.



Map showing the location of the Beauharnois Canal and power house, to have an initial installation of 500,000 hp.

BEAUHARNOIS: Canada's Largest Hydro Project

By E. G. WILSON
Ottawa, Ontario

ULTRA-MODERN engineering methods have brought the immense Beauharnois power canal project on the St. Lawrence River to a definite stage of development in less than one year. From a point near Valleyfield to another near Beauharnois, a canal of 3,000 ft. wide capable of carrying all the water in the St. Lawrence, is being built between Lakes St. Francis and St. Louis, as indicated on the diagram. All along the fifteen-mile route gigantic excavating machines are at work. In one place they are cutting a canal 27 ft. deep and in others, where the ground is low, dykes are being built. At the lower end of the canal a 1,000-ft. power house is to be built. One of the largest electric shovels is removing the rock blasted from the power house site. It has an 8-cu.yd. dipper on a 90-ft. boom.

For the initial development, the Beauharnois Power Corporation obtained the right to divert over 53,000 sec.-ft. of water around the Beauharnois section of the St. Lawrence. The original water lease permits the diversion of 40,000 sec.-ft., but since the project was initiated the water rights held by the Montreal Cotton Company have been acquired. These rights permit a further diversion of between 13,000 and 14,000 sec.-ft. As the St. Lawrence leaves the international section of the river near Cornwall, Ontario, and near St. Regis, N. Y., it enters the province of Quebec, where it widens out into Lake St. Francis. Twenty-five miles or so further on the river narrows into a series of four rapids (Coteau, Cedars, Split Rock and Cascades), where it drops a total of 83 ft. in what is usually called the Soulanges, or Beauharnois section of the river. It is this section which the Beauharnois Power Corporation is canalizing for power, and also for navigation.

Near Beauharnois the river again widens into a slow moving reach known as Lake St. Louis, which stretches about 20 mi. down to Lachine, a suburb of Montreal. The entrance of the new canal is on the southern shore of Lake St. Francis, a little more than a mile from the city of Valleyfield, Quebec. The route chosen for the canal takes a wide curve following the most favorable contours of the territory. The canal brings the water at the level of Lake St. Francis down to the shores of Lake St. Louis, where in a single-stage development is concentrated the 83-ft. head, between the two lakes.

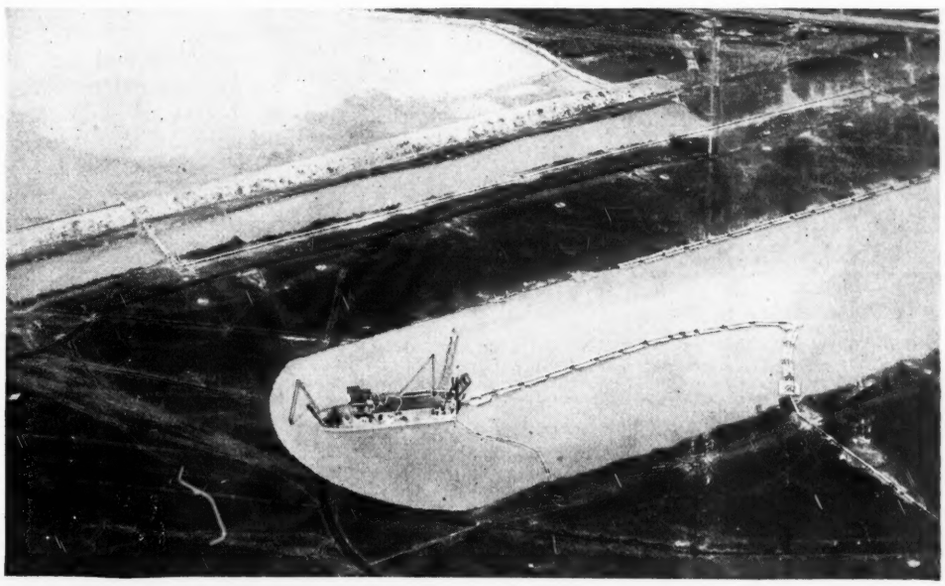
The initial power house is being built to house ten 50,000-hp. units. By Oct. 1, 1932, it is planned to

produce 200,000 hp. Further units will be installed from time to time thereafter to bring the plant up to its initial 500,000-hp. capacity.

Although the project is of great magnitude, it presents no major engineering problems. A profile of the proposed route shows the greater portion approximately level or below the head water at Lake St. Francis, which will result in light excavation over the greater part of the route. Total volume of material to be removed in the development of the canal is approximately 60,000,000 cu.yd. The ground contour is such that most of the excavated material can be used in the necessary embankments. The latter are not to be less than 40 ft. on the top. The material excavated is marine clay, and little or no rock is encountered except at the lower end, where the power house and locks will be located, providing an excellent foundation for these works. For the initial installation of 200,000 hp. some 20,000,000 cu.yd. is to be excavated. The 35 intake gates at the head of the canal will be of heavy steel construction, 50 ft. in width.

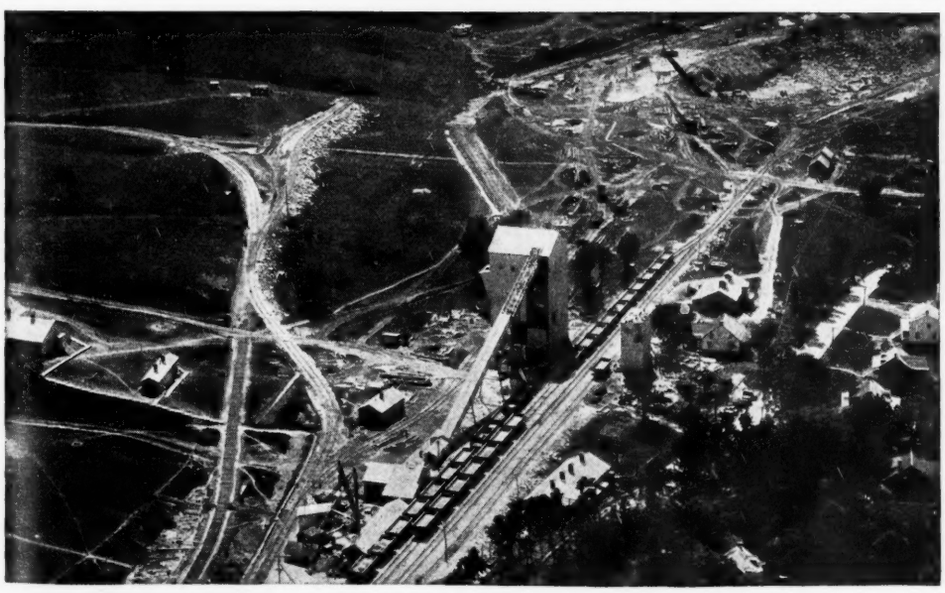
Large-scale excavating methods have been adopted by the company. The hydraulic dredge, the movable tower excavators equipped with 10-cu.yd. buckets, and the gasoline and electric shovels were assembled during the winter and early spring of this year. Since the beginning of large-scale operations, last spring, the efficiency of the equipment has been steadily increased. Power house excavations have reached the point where work has been started on the foundations. A concrete mixing plant, over 100 ft. high, has been constructed near the power house site. In all, the corporation is employing 2,000 men. In addition, the orders that have been placed with Canadian companies for electric and construction equipment and for supplies of every kind are probably giving employment to another 2,000.

Of its initial 500,000-hp. installation, 400,000 hp. has been sold at $15 a horsepower. Of this, 250,000 hp. goes to the Ontario Hydro-Electric Commission and 150,000 hp. to Montreal Light, Heat & Power, Consolidated. The first blocks of power under these contracts are to be taken Oct. 1, 1932, with increasing quantities year by year thereafter. The full amount of the contracts must be taken by the end of five years. The plant is virtually in the center of the prosperous St. Lawrence basin, which, with the cities of Toronto, Montreal and Quebec, is the most prosperous and highly industrialized section of Canada. But 25 miles from the plant lies the port of Montreal with its deep-water facilities.



Right—One of the largest hydraulic dredges in the world at work on the canal. In one month this dredge removed over 800,000 cu.yd. of material. When completed for the final development the canal will be 3,000 ft. wide and 27 ft. deep

Photographs by Compagnie Aérienne Franco Canadinne



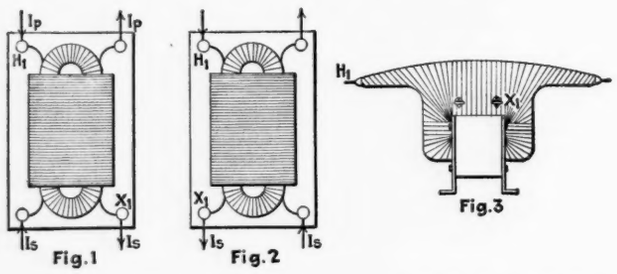
Left — Site of the construction camp and the power house at the lower end of the canal. The concrete mixing plant can be seen at the center of the picture, and at the upper right-hand corner is the site being excavated for the power house

Polarity Marking of Instrument Transformers

What transformer polarity is in terms of terminal markings and how to use these markings when grouping potential and current transformers to have them connected properly

By JOHN AUCHINCLOSS
Switchboard Engineering Dept. General Electric Co.

SEVERAL recent incidents have led to the belief that some misconception is still prevalent regarding the terms additive and subtractive polarity as applied to instrument transformers. During the period when most transformers bore no polarity indication these terms had a vital significance and bearing upon their proper connection to the secondary burden. The standardization of visible polarity markings, however, has largely done away with this, so that the terms, in relation to the external secondary connections at least, have lost much of their earlier importance.



FIGS. 1 TO 3—POLARITY MARKINGS ON TRANSFORMERS
Fig. 1—Potential transformer connected for additive polarity. Fig. 2—Potential transformer with its terminal arranged for subtractive polarity. Fig. 3—Current transformer terminal marked for additive polarity.

To illustrate: Take a potential transformer with polarity as indicated in Fig. 1. H denotes one end of the high-voltage winding and X the end of the low-voltage winding, while the subscript $_1$ indicates that these terminals have the same polarity, or, what is the same thing, that if H_1 at any instant is positive, then X_1 at the same instant is also positive. Consider what this definition means:

In any transformer the primary may be compared to a receiving circuit in which the internal current flows from positive to negative, while the secondary is equivalent to a generating circuit in which the internal current flow is from negative to positive. Applying the analogy to Fig. 1, we find that, at the instant considered, the direction of internal primary current flow is from H_1 to the unmarked terminal, while at the same instant in the secondary it is from the unmarked terminal to terminal X_1. Extending these currents to the external circuit, it is evident that the primary current must flow in at H_1 at the same time that it flows out at X_1.

For reasons which are beyond the scope of this article the polarity illustrated in Fig. 1 has come to be designated as additive. A different arrangement of the internal windings, however, may result in the polarity shown in Fig. 2. Here it will be noted that terminals of like polarity instead of being located diagonally with respect to each other are now in an adjacent position.

Applying the same reasoning to Fig. 2 as used on Fig. 1, we find that although the arrow denoting internal current flow in the secondary is now apparently in the reverse direction from that shown in Fig. 1, the currents in the external circuit still enter at H_1 and leave at X_1, as before. Consequently, regardless of the internal polarity of the transformer (additive or subtractive), the external currents have the same direction with respect to the external polarity marks H_1 and X_1.

Previously to the physical marking, the polarity of the transformer was determined solely by the terms additive and subtractive, the additive polarity unit having terminals of corresponding polarity located diagonally and the subtractive polarity unit having them adjacent. The construction of some modern transformers does not

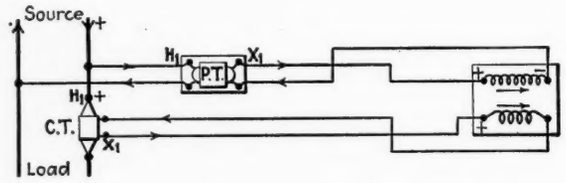
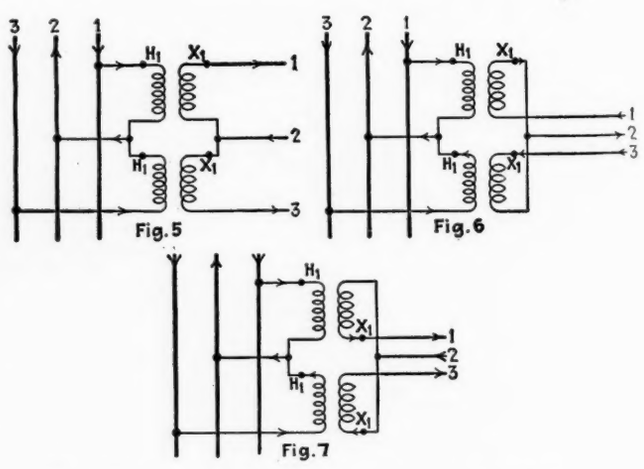


Fig. 4—Single-phase wattmeter connected to a potential and a current transformer



Figs. 5 to 7—Potential transformers grouped on a three-phase line according to their polarity markings

readily permit the application of the polarity terms. For example, consider the current transformer in Fig. 3. Here the terminals are so located that there might be confusion regarding which are diagonally or adjacently placed, and the only method of identifying the polarity is by means of the H_1 and X_1 markings.

Several classes of alternating-current meters, such as ammeters and voltmeters, in which no polarity relationship is required, function independently of the polarity marks on their operating transformers. Other classes, such as wattmeters and power-factor meters, will not operate correctly unless proper regard has been paid to these markings. The single-phase wattmeter, Fig. 4, will give a forward deflection on the scale only when the two right-hand and two left-hand studs have the same polarity. Assuming that the instrument transformers are installed and connected to the primary lines as shown, and taking the particular instant in the voltage cycle when the right-hand side of the line is positive, the instantaneous polarity across the transformers and at the meter studs may be readily traced. During the next half cycle all polarities are, of course, reversed, but the meter torque remains in the same direction, because a motor will continue to rotate in the same direction if both its armature and field current are reversed.

Various connections, equivalent to those in Fig. 4, are also possible. For example, the current transformer

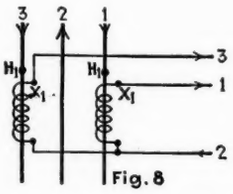


Fig. 8

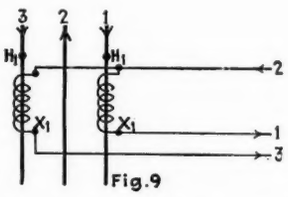


Fig. 9

Figs. 8 and 9—Current transformers grouped on a 3-phase line according to their polarity markings

could be connected in the other side of the line or its H_1 terminal could be connected to the load side. The primary terminals of the potential transformer could be connected to the sides of the line opposite those shown, or the connections to both coils of the meter could be reversed. No matter how the transformers are connected or what their polarity may be, it is only necessary, in the final analysis, that adjacent studs of the meter have the same instantaneous polarity.

Most circuits of electrical dimensions sufficient to require instrument transformers are polyphase. On such circuits the problem of properly connecting the wattmeter is not quite so simple, although even there no great difficulty is involved in extending the method already developed. It should be noted, however, that in the grouping of several transformers the resulting effective polarity across the group may be the reverse of that of the individual units comprising it. For example, in Fig. 5, two potential transformers of subtractive polarity are connected in open-delta in such a way that the resulting group polarity remains the same as that of the individual units, namely, subtractive.

In Fig. 6 the reversal of the secondary delta results in additive polarity across the group. As noted previously, the polarity of the individual units has no bearing on the ultimate group polarity if the polarity markings are adhered to. In Fig. 7, for instance, the polarity of the

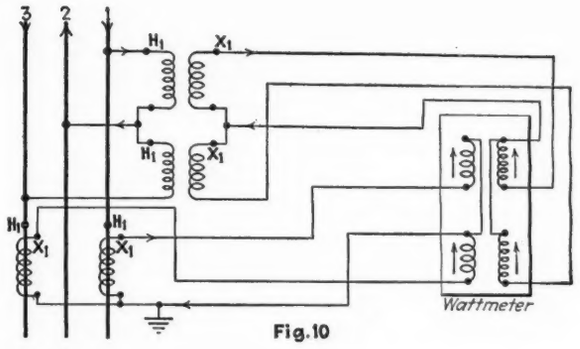


Fig.10

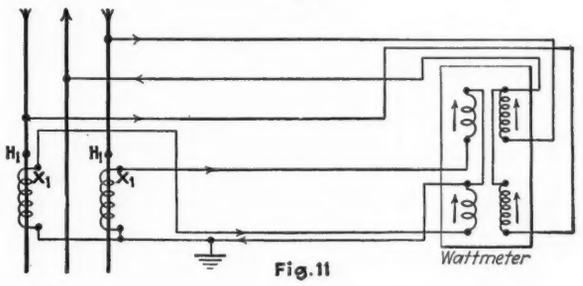


Fig.11

Figs. 10 and 11—Polyphase wattmeters connected to 3-phase lines

individual units is additive but the group polarity remains the same as that shown in Fig. 5, because the polarity connections have been exactly duplicated in both figures. In Fig. 5 the terminal X_1 of the upper transformer goes to secondary line 1, while the unmarked terminal of the same transformer connects with the X_1 terminal of the lower transformer to form line 2 of the secondary. The unmarked terminal of the lower transformer then forms a secondary line 3. Comparing these connections with Fig. 7, it will be observed that exactly the same polarity connections have been formed and these have resulted in a secondary polarity identical with that in Fig. 5.

The same reasoning may be applied to the grouping of current transformers. Fig. 8 shows two such transformers of subtractive polarity combined to produce subtractive polarity at the three-phase secondary. The same polarity connections are produced in Fig. 9 with individual units of additive polarity.

It will be readily apparent that a great number of current and potential transformer connections are possible that will still permit the correct connection of a polyphase wattmeter. Of these the particular connection most generally used among metermen is that in Fig. 10. The instrument transformers shown in this figure have so-called subtractive polarity. The same connections would, of course, also apply were the polarity of all the transformers additive.

A difficulty might arise, however, on low-voltage high-current circuits where current transformers only are used, the potential coils of the meter being energized directly from the line, Fig. 11. Here the potential connection from the lines to the meter is exactly the same as though potential transformers of subtractive polarity were used. If the reader is accustomed to a similar physical arrangement with potential and current transformers of additive polarity the omission of the additive-polarity potential transformer must be allowed for or a negative torque at the meter will result. If as stated before, however, the connections are based upon the polarity markings instead of polarity terminology, no such trouble should occur.

Dichloro-Difluro-Methane Overrated As a Refrigerant

By JOHN E. STARR

DR. THOMAS MIDGLEY of the General Motors created quite a sensation recently by exploiting what to the uninitiated was a new refrigerant. It is really not new, as it has been known to many refrigerating engineers for the last twenty-three years. It is called *dichloro-difluro-methane* and was first announced by Swartz of Belgium in 1907.

Its low boiling point at the atmosphere of —18 deg. F. and its low pressure at 70 or 80 deg. F. brings to the attention of the refrigerating engineers its peculiar availability as a refrigerating fluid, but its unfavorable reaction on most metals and the possibility of its dissociation under superheat gives pause as to its adoption.

The physical properties are well known. Based on the behavior of all other gases, I calculate the pressure temperature relations to be as follows:

Temperature, Deg. F.	Pressure, Lb. per Sq.In. Abs.
—20	14
—18	14.7
—16	18.5
— 5	21
0	23.5
5	26
10	28.5
15	31.5
20	36
25	40
30	46
35	50
40	54
45	60
50	64
55	77
65	84.5
70	93
80	105.75
86	116.5

The United States Bureau of Health gives a slightly different curve, based on the formula of Blumke, but this curve cannot be right, as by it the boiling temperature at 14.7 lb. is —22.5 deg. F., while the other curve gives —18 deg. at 14.7 lb., which is understood to be correct. However, as at 15 deg. F. there is only about one-half a pound difference between the two, and as the pressures at other temperatures are nearly alike, it makes no practical difference in the design of a machine, for 15 deg. F. is the usual working temperature in all small machines.

The head pressures are probably low enough to admit it to the air-cooled class of condensers. The volume at 5 deg. and atmospheric pressure is 1.64 cu.ft., indicating a reasonable displacement, somewhere near 1.5 times that of ammonia and less than sulphur dioxide. The displacement per minute per ton at the standard temperatures of 5 deg. and 86 deg. is 5.2 cu.ft. per ton with adiabatic compression, and will probably require from 6.6 to 6.4 cu.ft. On a small machine it may take 8.5 or 9 cu.ft. of measured cylinder displacement and a little more horsepower per ton than ammonia, but in the horsepower required by a small machine this will not make very much difference.

Dr. Midgley states that the fluid is not intended to replace the fluids now in use in small machines, "as the latter are perfectly satisfactory," but is intended to broaden the use of refrigeration by large machines, which by reason of the safety of the gas could be used in cooling areas of occupancy such as auditoriums and dwelling houses on shipboard and in mines

It would appear just the opposite: A large number of the fluids now used in domestic or small-machine refrigeration are eminently unsatisfactory from a sanitary standpoint if the American Medical Association can be believed. For example, sulphur dioxide, used by 80 per cent of the small machines, is regarded by this association as particularly objectionable because the escape of a very small quantity of the gas is dangerous to life and health.

Large machine owners are well satisfied with ammonia, a dangerous fluid if it does escape, but the risk is purely an occupational one, affecting only a small part, 0.2 per cent, of the public; while the small machine is an occupancy risk affecting the entire public, men, women and children, living under conditions where measures of safety are impossible. Besides the large machine has at its command a fluid long used that is just as safe as *dichloro-difluro-methane.*

Carbon dioxide is apparently as safe as *dichloro-difluro-methane,* for the only objections advanced against its use is its substitution for oxygen in the atmosphere in case of a leak, and the consequent possible "drowning" of one exposed. *Dichloro-difluro-methane* contains no oxygen and is therefore subject to exactly the same objection, so that carbon dioxide meets all the requirements that *dichloro-difluro-methane* does, and large carbon-dioxide machines have been in use for many years.

The two fluids stand on a par so far as toxicity is concerned and so far as the exclusion of air is concerned; but carbon dioxide cannot be so well used in a small machine; hence the desirableness of a non-toxic fluid for a small machine, even if we cannot hope for absolute safety. However, in a small machine we can approach near absolute safety if we employ a non-toxic fluid, even though it does replace air in case of a leak. For the quantity of fluid used on a small unit machine is so small as to obviate danger from "drowning."

On account of the drowning feature it is doubtful whether *dichloro-difluro-methane* should ever meet with approval for the multiple system where large amounts must be used. Heretofore when carbon dioxide was used to refrigerate a number of boxes from one machine the safe brine has always been used as a means of distribution.

On the whole, there seems to be little to ascribe to *dichloro-difluro-methane* over the value now possessed by fluids already in use, except possibly the apparent advantage of its use in connection with air cooling, which is perhaps more than offset by its unfavorable relation to present methods of construction.

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THE CONSUMPTION OF LUBRICATING OIL by a diesel engine is affected not only by a mechanical design of the engine but also by the quality of the lubricating oil, the arrangements for storing, cleaning and circulating, and the skill and integrity of the personnel of the plant. All of these factors with the exception of the first, are so obviously beyond the control of the manufacturer that it is not feasible or logical for a responsible builder to guarantee the lubricating oil consumption of his engine. —*Standards of the Diesel Engine Manufacturers.*

Critical Speed In an Engine Shaft

To the Editor:

Last week whom should I encounter but an old friend whom I shall call Aloysius Barber, since this is what his parents wished on him. However, knowing his objection to his honestly earned name, I addressed him as Bill and inquired how things were.

Bill replied that he was suffering from "critical speeds." It seems that he is operating a plant containing a six-cylinder oil engine on a dredge. Due to a change in the pump, he had boosted up the speed a trifle and, as he put it, the engine developed an ague, which the service man termed "a critical." I had to admit to Bill that I knew all about it, or at least as much as he, an operating man, need know, and was willing to be gossipy if Barber could find the means to buy us a steak dinner.

After I had partaken of as much food as Bill was willing to underwrite, I cleared off a space on the tablecloth, so the proper sketches could be made. What I told Bill was about as follows. **DONALD McFEE**

THOSE who desire to delve deeply into crankshaft torsional vibration will find in various technical papers presented before the several engineering societies very complete studies and calculations. No attempt will be made here to go so deeply into the subject, but instead a simple outline of what torsional vibration is, how it is set up and how avoided will be given. It is intended to meet the needs of the operating engineer.

If a weight be suspended by a spring, as shown in Fig. 1, it will be found that when the weight is given a downward pull the weight and spring will commence to bob up and down with a decreasing displacement, or movement, until the weight finally comes to rest. The observer will notice that even though the movement, or downward displacement, gradually diminishes, the time interval occurring while the weight completes a cycle of downward and upward motion remains constant. If the weight is small compared to the mass of the spring, so that its inertia has little influence, this cycle interval, or period, depends upon the length and coil diameter of the spring, as well as upon the thickness of the spring wire and its structure. If the spring is weak and long, the period will be long; while if the spring is short and thick, its period is short and the cycle occurs many times more often per minute, but the displacement will be less.

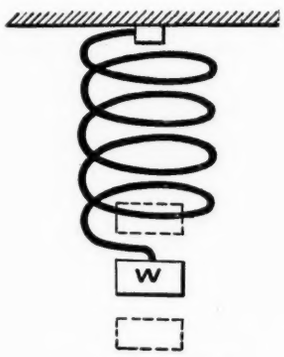

Fig. 1—Vibration of a spring

A similar action takes place if we attach a lever to a coil spring as in Fig. 2. If given a push, the lever will oscillate as the spring winds and unwinds. In fact, the balance wheel of a watch works in this fashion.

It will be found that if the lever is given an angular displacement, or twist, it will not only return to its original position but also go beyond it a distance almost equal to the original twist. A reversal of angular travel then occurs, and the alternate winding and unwinding of the spring will continue until it finally comes to rest. This is essentially a torsional vibration of the spring, and the time taken for the cycle of twist and untwist depends upon the spring form and character.

If a straight piece of shafting is bolted to a wall, as in Fig. 3, a force exerted on a lever bolted at the outer, or free, end will cause the shaft to twist and untwist, or otherwise to experience torsional vibration. The amount of twist the shaft experiences will depend upon the force applied.

If, after applying the force once to set up a vibration, the force is applied again at the proper time, the twist will be greater than before, and if a series of impulses is given to the lever the amount of twist, or angular displacement, of the shaft will be increased to a marked extent. In fact if the force is great enough and applied enough times, the shaft may be twisted off.

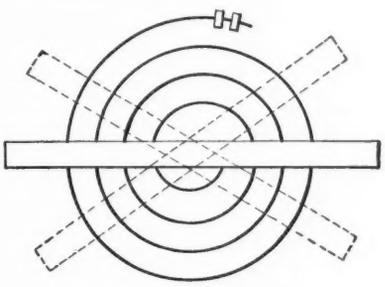

Fig. 2 — Oscillations of coil spring are torsional vibrations

Ordinarily, a shaft is not fixed, but revolves in bearings and carries a flywheel. The action, however, is the same as with a fixed end. Suppose the shaft is mounted on two bearings, at the points indicated by arrows, with a flywheel at one end and a lever at the other end, as in Fig. 4.

The flywheel weighs so much in comparison with the shaft that an ordinary force applied to the lever will merely twist the shaft, as when one end is bolted to a wall. If a line is scratched along the shaft, it will be discovered that where the shaft is twisted the angular displacement of any point on the line decreases as the point approaches the flywheel, and at the flywheel no twist is seen. In other words, the shaft inside the flywheel hub is a node. However, if the flywheel is light

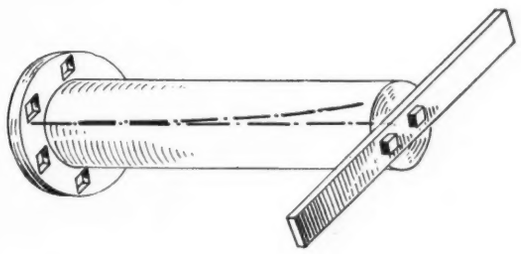

Fig. 3—Torsional vibration of a shaft

in weight the node, which is always located at the center of gravity of the combined shaft and wheel, might be at some point between the flywheel and the free end of the shaft.

If the flywheel is at the center of the shaft length and if a force is applied to both ends of the shaft in opposite directions, the two halves of the shaft will be twisted, or displaced, in opposite directions, with the part inside the hub stationary; it is still a node.

If the shaft and flywheel already discussed are rotated and a force is applied to the lever, the twisting of the shaft will occur as in the case where the flywheel was at rest.

The longitudinal scratch placed on the shaft will, of course, be in rotation, but will be a straight line as long as the force is not applied. A thrust on the lever will cause a shaft twist, evidenced by the scratch's becoming a helix; but at the flywheel the twist becomes zero and the shaft maintains its original position in respect to the flywheel; in other words the node, or no-twist point, still exists at the flywheel even though the shaft is turning. If a single impulse is given to the lever the twist of the shaft is small, but if an impulse is given the lever each time the shaft untwists and travels to the other end of its angular displacement the next displacement, or twist, will be greater. If the impulses are continued in synchronism with the periodic movement the displacement may become very great, and under extreme conditions the shaft may be sheared or broken.

If the impulses are not in synchronism with the period of the shaft's twisting they will have no effect on the shaft's twist save when one of the impulses does occur at the proper time, but will tend to dampen the vibration, just as a person on a swing can be brought to rest by another on the ground giving a push at the wrong time.

To extend the torsion study to engine crankshafts, let us assume that the lever on the shaft end is replaced by a crank connected to a connection rod and piston of an engine, as in Fig. 5. Assume that the shaft and

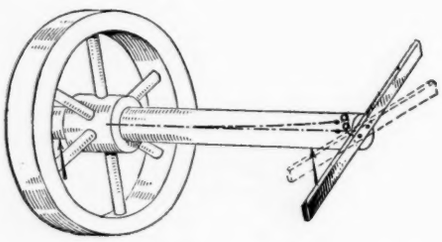

Fig. 4—The flywheel acts as a fixed end

flywheel are rotating. At the first explosion, or firing, in the cylinder, the shaft twists, and if the firing impulses coincide with the natural vibration of the shaft set up by the original firing, the shaft will twist and untwist violently, that is, extreme torsional vibration will be set up, leading to ultimate fracture of the shaft.

For example, suppose that when given an initial twist the shaft vibrates at the rate of 60 times a second. If the cylinder turns the shaft at 300 r.p.m., or 5 times a second, and fires at each revolution, only 5 impulses will be given per second while the shaft naturally vibrates 60 times per second. The influence of the firing on the shaft's torsional vibration will not be of any moment, and the friction in the bearings and in the shaft fibers would probably destroy the effect. As the relation of the number of the firing impulses to the shaft's natural frequency of vibration is 12, we can say that the condition is a critical speed of the twelfth order.

But if the engine had four cylinders firing at each revolution, we would have 20 impulses per second, or there would be a critical speed of the third order. Some shaft vibration might be encountered, which would be dampened out if the speed were changed to, say, 260 r.p.m.

On the other hand, if the engine had six cylinders which fired on each revolution, and the engine ran at 300 r.p.m., or 5 per second, the firing impulse would be 30 per second, or the shaft would receive a forced

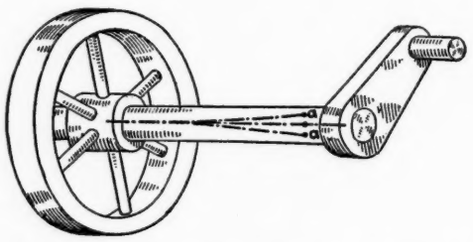

Fig. 5—Replacing lever with crank does not change action

impulse at every other period and the torsional vibration would be violent. Thus a six-cylinder two-stroke-cycle engine at 300 r.p.m. would, if its shaft had the natural period assumed, have a critical speed of the second order.

If the engine had 12 cylinders, the firing impulses would equal the shaft's natural period and the vibration would be so violent as to wreck the engine.

It should be understood that the assumed natural period is actually much under that existing in an actual shaft.

It will be noticed that with any given shaft the tendency for torsional vibration to occur increases with an increase in the number of cylinders. In addition, an increase in the number of cylinders requires lengthening of the shaft to accommodate the crank, which results in a more flexible shaft and a decrease in its natural period. This means that the engine's speed must be reduced unless the shaft's diameter is enlarged to make it stiffer so it will have a high vibration period.

For this reason crankshaft breakage due to torsional vibration seldom occurs on an engine having less than six cylinders. Vibration in engines of a lesser number of cylinders is generally due to unbalance of the reciprocating and rotating parts.

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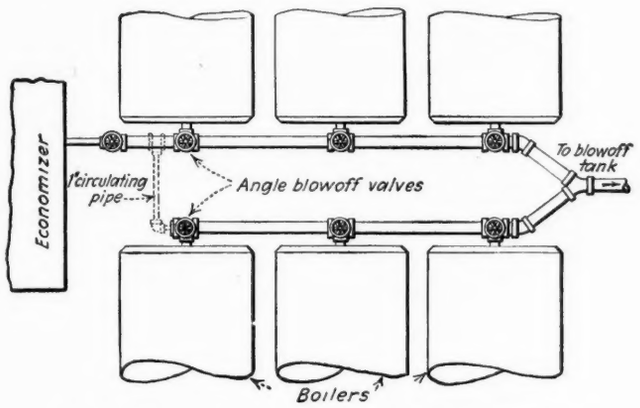
SOME OF THE AVAILABLE METHODS of constructing charts for the graphical solution of complicated equations are described in a paper, "The Construction of Diagrams for Formulas," which was presented at the recent general meeting of the Society of Naval Architects and Marine Engineers by Herbert L. Seward, professor of mechanical engineering in the Sheffield Scientific School of Yale University. Professor Seward discusses at length both the Cartesian and alignment diagrams and claims to have simplified the latter to a point where it can be used with comparative ease and convenience. Diagrammatic explanations are given in the paper to show just how the charts may be constructed, and many typical examples are included to illustrate the application of these charts in the solution of formulas.

...RIGHT OUT OF THE PLANT...

Troublesome Blowoff System Corrected

THE STEAM-MAKING PLANT of a manufacturing works consisted, originally, of three horizontal return-tubular boilers. Three more boilers of the same type were installed and a fuel economizer was added. The accompanying sketch shows a plan view of the complete installation, the two groups of boilers being set back to back, with an intervening space in which the blowoff pipes were laid. The 2-in. blowoff pipes running out from the boilers were connected to two 4-in. mains which merged through a branch fitting in a single main



Circulating pipe cross-connecting blowoff mains relieves water hammer

pipe. This pipe ran out to a blowoff tank sunk in the ground about 50 ft. from the boiler house. The blowoff pipe leading from the economizer was joined to one of the branch mains.

At first the arrangement did not work satisfactorily. When one set of boilers was being blown down a severe water-hammer would occur in the main branch to which the other set was connected. The difficulty was remedied by running a 1-in. connecting pipe between the inner ends of the branch mains, as shown by the dotted lines.

St. Louis, Mo. A. J. DIXON.

Faulty Packing of Stuffing Boxes

STUFFING-BOX TROUBLES are among the most prevalent in power plants. Generally, they are not so much due to lack of enduring qualities in the packing materials as to mistakes in using such materials. Some engineers experience trouble with every brand of packing they select, while others scarcely know what packing troubles are.

Slipshod work in caring for stuffing boxes is evident in many plants. All kinds of packing may be used, and all applied haphazardly, with utter disregard for the printed directions given with each. If the right kind of packing is not available, some operating men will use anything that appears likely to serve as a substitute. Asbestos in wick form, cotton lampwick, manila rope, anything in the way of cotton or hemp that is stringy enough, is likely to be used to pack the water ends of pump rods, while packings intended solely for hydraulic service are used on steam rods. And regardless of whether the right kind is on hand later on, such packing often is allowed to stay in the stuffing boxes as long as the glands can be pulled up tight enough to prevent leakage.

Advice as to how the packing should be used comes with every brand available. When such specific instructions are overlooked, trouble is sure to result, and much futile experimenting probably will be done in trying to avoid the trouble. An engineer bought what to him was a new brand of piston-rod packing. Without reading the directions he put the packing to immediate use on his engine. At the end of two weeks the stuffing box had to be repacked, the first application having shredded out completely. After repeating the operation every two weeks for four months the engineer read the directions and learned that he had been putting the packing in wrong-side-to. During those eight weeks he had been denouncing the packing as utterly worthless.

Common sense and observance of the "instructions for use" are necessary to realize success with any packing. But the packing job is often delegated to men who have scant appreciation of this. If there are any indications of difficulty in removing the old packing, they will jam one or two new rings on top of a set that may have been in the stuffing box for a year or more. If the rod continues to leak, they are likely to draw the gland up until the packing cannot be compressed further. Scoring and irregular wear of the rod follow. Shoulders forming on the rod prevent it from being made tight no matter how carefully it may be packed subsequently.

Besides being bad for the rod, allowing a set of packing to remain in a stuffing box as long as it can be drawn up tightly enough to prevent excessive leakage, imposes an extra load on the machine. If it is a pump, the friction thus produced may interfere with the pump's action. Unequal tightening of the piston-rod packing on duplex pumps is often practiced to make the two pistons travel at an even speed, no thought being given to the added steam consumption and the increased wear and tear.

On the other hand, the blame for stuffing-box troubles

cannot always be ascribed to negligence and lack of skill on the operating man's part. Structural defects often are the cause. Sometimes the stuffing boxes of steam pumps are not centered truly, so that the packing hugs the rod tightly in one half of its circumference and loosely in the opposite half. Or the clearance in the throat of the stuffing box may be excessive, in which case the packing will squeeze through and become jammed between the rod and the wall of the throat, thus wearing the rod unevenly and shortening the life of the packing.

Some operating engineers seem to have small appreciation of the loss due to imperfect packing of the piston and plunger rods of steam pumps. Where compound duplex pumps are used, with eight piston-rod stuffing boxes on each, the annual loss from friction may reach a considerable sum. And where the packing is allowed to remain in the stuffing boxes until it becomes vulcanized, clamping and scoring the rods under a heavy gland pressure, the price paid may be that of many tons of coal.

But the extra fuel burned is not the only loss. The expense of truing up scored rods and replacing those worn out prematurely is considerable. The steam leaking out of poorly packed stuffing boxes represents another loss, while the frequent repackings which damaged rods require also figure up to extra dollars and cents needlessly expended.

The gland pressure on fibrous packing rings causes the rings to expand laterally—out against the wall of the stuffing box and in against the rod. Where the bottom of the stuffing box is beveled, as is the usual practice, and the contact end of the gland also is beveled, a wedging action occurs that causes the rings at top and bottom to hug the rod more tightly than do the intervening rings. For this reason many engineers require that the bottoms of the stuffing boxes on the pumps they purchase be bored square with the axis, and that the ends of the glands be turned off likewise. D. J. ALLISON.

Chicago, Ill.

Experiences With Full-Voltage-Start Motors

FOR SUPPLYING water at 2,500 lb. per square inch to a number of presses and molds a triplex pump geared to a 50-hp., 440-volt, high-reactance type motor was installed about a year ago. Initial operation was satisfactory, except at times the pumping unit was subjected to severe mechanical shock when starting, as evidenced by vibration and noise. The pump is started against nearly full pressure, and normally operates for two-minute periods approximately six minutes apart.

An explosion in the magnetic switch, which burned the conducting parts and bent the cover of the case, was the first trouble experienced. The short-circuit that developed was cleared by the fuses blowing. After repairs, during which the insulation was materially reinforced, operation was satisfactory for a time, but a second explosion occurred. Repairs were again made and operation resumed pending an investigation by the motor manufacturer. While this investigation was under way the magnetic switch failed to open, probably due to weak contact spring pressure caused by overheating. Some damage was done to the control mechanism before the engineer could diagnose conditions and stop the motor by opening its switch. Pressure from the pump normally lifts a heavy accumulator cylinder three feet, and the vertical movement of this cyinder operates, by weighted steel cables, control switches connected in series with the operating coil of the magnetic switch.

Because of these difficulties the magnetic switch was replaced with a much heavier one having temperature overload relays of greater time lag. No further trouble has been experienced with the control equipment since this change was made.

A signal horn, supplementing a signal lamp originally installed, was arranged to give audible warning when the accumulator cylinder rises above the safety-stop control switch. The magnetic switch operating coil is de-energized by the opening of the normal stop control switch. The pump is started when the accumulator cylinder closes a control switch when moving downward. A bell rings when the cylinder drops below this point.

Two theories have been advanced to account for the explosions. One is that the control case, which was not ventilated, became filled with conducting gases due to frequent opening of the contacts and caused a short circuit. The more rational theory appears to be that the temperature overload relays, because of the high room temperature and the motor's large starting current, caused the magnetic switch to open while the current exceeded its rupturing capacity.

Some time after the installation of the heavier magnetic switch the motor's stator coils were found to be loose. This trouble appeared to be caused by shrinkage of the insulation and stresses resulting from the heavy starting currents. The coils were made tight by using thicker slot wedges. All of these difficulties were corrected by the manufacturer without controversy or delay. Replacement of the pump's drive gear and realignment of the motor largely eliminated the severe mechanical shock formerly noticed at times when the motor was started.

While the simplicity of across-the-line starting recommends it, that factor may be found to be outweighed, for this particular application, by the high maintenance costs. Although all the electrical difficulties appear to have been overcome some time must elapse before undue mechanical strain or wear will be evidenced.

A pumping set of the same size, but driven by a wound-rotor motor, and operating under nearly identical conditions as those stated above, has given excellent service for over nine years. The motor is automatically controlled, there being three steps of resistance in the rotor's circuit. Starting and acceleration is made smoothly and without shock. The maintenance cost of the control equipment has been very low.

Motors not designed for starting at full-voltage sometimes give excellent service if started in this manner. A triplex pump designed for 250 lb. per square inch pressure was originally driven by a 15-hp. wound-rotor motor automactically controlled. This pump operates approximately one minute out of every three, starting being done under full pressure. After experiencing continual trouble with the starting equipment the motor was started across-the-line by using only its primary magnetic switch, the collector rings being short-circuited. This method of operation has been employed for several years, and no difficulties have arisen. D. ROBERTS.

Seattle, Wash.

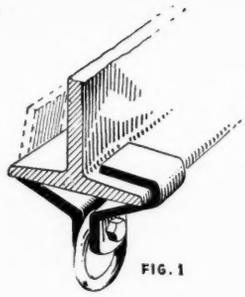


FIG. 1

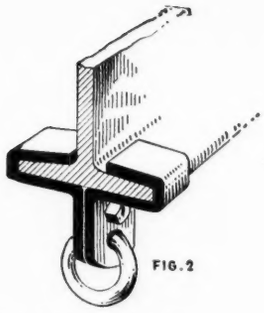


FIG. 2

Suggested and improved I-Beam clamp

Clamps for Anchoring Chain Hoists to I-Beams

THE NOV. 4 number of *Power* brings forth a comment by G. W. Clarke and an accompanying sketch on the subject of I-beam clamps. I certainly agree with Mr. Clarke that for heavy load the type of improvised clamp of conveyor chain links such as W. S. Whiting, Jr., contributed are not safe. Still there was for some of us a unique use for those links for a light load.

In attempting to correct what appears to Mr. Clarke an unsafe type, he offered another design on which I offer the following comments. From the sketch given, it would appear that the clamp has three defects: First, that under a heavy load the clamp might tend to straighten out as in Fig. 1 of the accompanying sketch; second, the eye-ring is held by the bolt against free movement, which is an unhandy feature in rigging chain hoists (also it may be bent were the load pulled from a tangent); third, the whole load will come on the body of the bolt.

In Fig. 2 is a design that is in use at the navy yards and on board ships of the navy for safe I-beam clamp rigging. The ring is welded and the clamp is well fitted and butted together. CHAS. H. WILLEY.

Pennacook, N. H.

Does Wetting Coal Improve Combustion?

I AM HAND-FIRING a battery of horizontal return-tubular boilers, and have for some time had to operate with a coking coal, of about 12,500-B.t.u. This coal has a large per cent of small dust, which is practically impossible to fire as it cokes at once into hard lumps that cannot be broken up without clinkering.

Three things result from wetting this coal. The lumps become soft enough to be scattered by throwing the coal against them, thus giving a flat, even fire. The furnace temperature is higher, and the combustion is quicker and more complete, with less smoke. Is it probable that the water is disintegrated into hydrogen and oxygen immediately on coming in contact with the incandescent coke bed, as does steam when passed through a red hot pipe, and that the oxygen content plus that disintegrated from the draft air is sufficient in quantity to attack the fixed carbon much quicker than that from the draft air alone.

Some seem to think that this water is converted into superheated steam and passes out with the flue gas, thus reducing the available B.t.u. of the fuel. If so, why the higher temperature and better combustion?

Medical Lake, Wash. CHARLES G. FORBES.

Determining Average Demand of Fluctuating Loads

LOAD CHARACTERISTICS play an important part in the cost of power. Usually rates are based on maximum demand, together with a fixed charge per motor horsepower, with a sliding scale per kilowatt-hour. It is therefore important to know what the average demand is, so that the connected horsepower in motors may be adjusted to give a minimum billing. At the same time it is desirable to keep down, so far as possible, the maximum demand. Unless one has had experience in measuring fluctuating loads, a number of errors may creep in.

Usually, tests to determine the average load are obtained by portable instruments, ammeter, voltmeter and power factor meter. Observations may be made by two or three persons simultaneously at regular intervals, such as every 2, 5, 6 or 10 min. These results thus obtained are then jotted down in columns and added up and averaged.

This method of determining average load is subject to error, which will be greater according to the frequency and magnitude of the fluctuations. There are the individual errors of the instrument and the individual errors of the observers. There are the errors due to inability to catch the average swing as based upon the observations, 2, 4, 6 or 10 min. apart.

A much more accurate and dependable way is to connect a wattmeter in the circuit. After being sure that the wattmeter is connected correctly the average load is obtained as follows:

Using a stop watch, count the number of revolutions per minute of the wattmeter disk. Count the revolutions per minute over one- or two-minute intervals, taken with a space between of one minute. In other words, if the test is made for eleven minutes, the revolutions over 4 two-minute periods will be obtained. These are averaged. The result is the total number of revolutions over an eight-minute period. Readings may be made for two-minute periods with a five-minute interval during the course of an hour, or several hours as best appears to meet the needs of the test.

After the readings have been taken it is a simple matter to determine from the meter constants the actual kilowatt-hours or horsepower of the load.

If it is desired to "check and double check," indicating instruments should be used in addition to a wattmeter. Care should be taken, however, to employ separate potential and series transformers for the indicating instruments, otherwise the wattmeter readings may be in error.

Determination of power factor is an important one in the majority of cases, so that a power factor meter is also desirable. Where two observers are used on the job, it is desirable that the observer not watching the wattmeter should watch the indicating ammeter to determine the maximum and minimum current swing, or, if an indicating wattmeter is employed, to jot down the maximum and minimum watts indicated. The man who watches the indicating wattmeter can use two stop watches, one to indicate the interval between maximum demand and the other to indicate the interval between the minimum demand. In this way a good general idea of the load characteristics of a plant or system can be obtained. R. K. LONG.

Chicago, Ill.

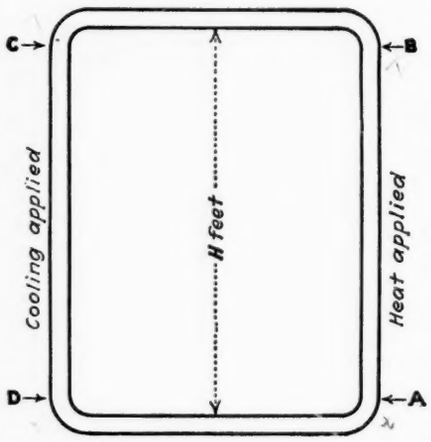
From Among Readers' Problems

Conducted by
L. H. MORRISON

CIRCULATION IN A HEATING SYSTEM—*We are all familiar wtih the fact that hot water is lighter than cold water and any engineer will tell you that this difference in specific gravity is what makes the home hot-water heating system function. Keeping this law in view, an apparent paradox is presented by the hypothetical case shown in the sketch.*

This covers a frictionless closed-circuit tube of uniform inside cross-sectional area. The total vertical height is H feet. On the right-hand limb heat is supplied to the tube, while on the left the tube is subjected to cooling, the amount of cooling equaling the amount of heating. Let the inside fluid temperature at A be t deg. and the temperature at B be T degrees. Section BC is considered perfectly insulated, so the temperature at C will equal T deg. From C to D the tube is subjected to cooling, so that at D the temperature is again t. The level section DA is also insulated. Temperature T is below boiling point.

At first sight this seems a perfect example of heat-induced circulation, but look a little closer. On the right the temperature varies from t to T, an average of $\frac{T + t}{2}$ *and on the left the temperature varies from T to t, an average of* $\frac{T + t}{2}$. *If the average temperatures are the same on both sides, the average specific gravity and the weight of fluid is also the same; so whence comes the motive power or head to induce circulation?* E.S.S.



The Hypothetical Heating System

The question could be answered somewhat along the lines of the defense offered by an accused's lawyer, who claimed that in the first place the accused was not present when the victim was shot; that the victim was not shot as charged in the indictment but was stabbed; and finally that the assumed victim was really not dead at all.

The hypothetical heating system does not resemble a house heating system, for in the latter the heat is applied at one place, the furnace, say at *A*, and cooling takes place from *B* to *C*, not from *C* to *D*; so that the water density along *AB* is not the same as along *CD*.

In the second place, if the pipe is frictionless, as assumed, when the water once starts to circulate it will continue to do so even though the density be identical throughout the system. Finally there will be no continuous circulation at all.

The system, which is a theoretical one, would act somewhat as follows: Before heat is applied the water in all parts of the system is at one identical temperature. When heat is applied from *A* to *B* the density of the water in this leg decreases and a flow is induced from *B* to *C* and down *C* to *D*. Cooling speedily makes the density of the two water columns identical, at which flow ceases. Continued heating again induces a flow, which is again stopped by the cooling.

EFFECT OF BOILER SCALE—*Statements often appear to the effect that even a small thickness of scale will seriously affect the boiler efficiency. Are these accurate?* L.B.

Investigators have never reached complete agreement on the effect of thin scale upon boiler efficiency. C. E. Schmidt drew from a series of tests on locomotive boilers the conclusion that with ordinary scale thicknesses up to $\frac{1}{8}$ in. the loss in heat transmission varies in individual cases from insignificant amounts to as much as 12 per cent, the loss increasing somewhat with the thickness. But the mechanical structure of the scale is of more importance than the thickness.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

WHAT effect on the plates, tubes and other metal parts does changing a boiler from a high-pressure to a low-pressure installation have? My experience is that where this is done the plates and tubes pit and corrode, and it is my belief that at the lower pressure the temperature of the water is just about right for active corrosion and pitting. J.C.

ONE OF THE principal causes of pitting and corrosion of tubes, plates and metal parts of boilers is liberated oxygen in the water.

I have found that where boilers are set from high pressure to low pressure the boiler is no longer required to be fed by pumps and injectors but by the city mains or like source. Some boilers pit and corrode more rapidly, while others do not. This, in my opinion, tends to show that the oxygen could not be liberated, as is many times the case where an injector is used and the water is taken from an open tank.

I believe that the actual condition of the water used, whether at high or low pressures, is the governing factor of pitting and corrosion.

While inspecting a six-drum water-tube boiler in western Pennsylvania some years ago, it was noted that active pitting had attacked the plates of the rear lower drum, while the rest of the drums were not affected. The boiler operated at 150 lb. pressure, and the feed water entered the boiler through this rear lower drum. I realized that this drum was the coolest part of the boiler, but the pitting puzzled me, so I took the matter up with metallurgists and chemists, and was advised that pitting would naturally be most active in the coolest part.

This theory might have been correct, but it does not seem to hold true, for I have seen locomotive boilers that pitted, corroded and grooved at the seam where the side sheets meet the crown sheet, this being about the hottest part of the boiler.

In one locality in New York the water is so bad that tubes in boilers do not average two years, regardless of whether the boilers operate at 1 or 300 lb. pressure, so it can readily be seen that low pressure is not wholly to blame for pitting on boiler plates and tubes.

I know of locality where the water is so bad that boilers do not last two years even when operated at a pressure of 125 lb. I was called in to advise why a boiler was leaking in the barrel directly over the fire. Removing the handhole plate, I found the entire shell of the boiler over the fire honeycombed. I advised that the water be analyzed, which was done. The analysis showed a strong acid element, and the man analyzing the water refused to recommend a water softener or other apparatus, claiming that the only remedy was a change in source of supply.

CHARLES W. CARTER, JR.
Binghamton, N. Y.

THE EFFECT on the plates, tubes and other metal parts of changing from high pressure to low pressure is not a matter of temperature.

It is assumed that while the boiler was run at the higher pressure continual feed was taking place and the solids in the water formed a protective coating. Also, circulation was more or less rapid. Both of these factors usually check pitting and corrosion.

I suggest that the feed water be analyzed, and a corrective formula be obtained. If the boiler is run continually as a heating unit frequent change of water is desirable to overcome the tendency of the water becoming too pure, which has a decided pitting effect. Also long periods of idleness, with the boiler full of water, should be avoided. JOHN GRAHAM.
Pittsfield, Mass.

ASIDE from pitting and corrosion, if this boiler, whose furnace and baffles are constructed to take advantage of the radiant-heat qualities of high-temperature furnace gases, is converted into a low-pressure unit without suitable alterations tube failure will result, provided the boiler is a water-tube type wherein the circulation is retarded.

With a furnace temperature of about 2,500 deg. F., and the gases leaving the boiler at a temperature of about 550 deg. F., a vigorous water circulation is set up.

In low-pressure operation, with a furnace temperature of about 1,000 deg. F., and the gases leaving the boiler at a temperature of about 400 deg. F., the heat absorbing surfaces of the boiler are at a small difference in temperature and a comparatively sluggish circulation is set up. If there is retarding construction in the boiler, such as headers, header to drum nipples, the water circulation will be insufficient to sweep away the steam bubbles as fast as they are formed, resulting in steam pockets and burned-out tubes.

WILLIAM ANDERSON.
Brooklyn, N. Y.

A Question for Our Readers

SOME raw-water ice plants use high-pressure air for agitation in the cans; some low-pressure air. Under what conditions has one the advantage over the other? Is there any difference in the freezing time of ice whether high- or low-pressure air is used for agitation? If there is a difference — Why? J.W.D.

Suitable answers from readers will be paid for and published in the Jan. 20, 1931, number

CORROSION of boiler metal is almost invariably traceable to oxygen and carbon dioxide contained in the boiler water. The oxygen-bearing capacity of water is dependent upon its temperature—the lower the water temperature the more oxygen it can carry.

If the boiler feed-water temperature were reduced along with the operating steam pressure, it can be clearly seen that its oxygen-bearing capacity would increase and corrosion could be expected unless thorough deaëration of the feed water were practiced. Regardless of operating pressure, the boiler feed water should be deaërated by heating to 212 deg. F. in an open heater vented to atmosphere.

Corrosion also results from formation within the boiler of free acid, such as hydrochloric, by the breaking down of magnesium chloride. This type of corrosion would be accelerated by high pressure and would be diminished by a reduction in the operating pressure. Distilled boiler feed make-up water would result in a boiler water entirely free from scale-forming and corrosive impurities.

If thorough deaëration of boiler feed cannot be accomplished, a protective paint can be applied to interior surfaces of the boiler which will be of assistance in combating corrosion.

J. M. TOTTEN.
Mount Vernon, N. Y.

TO COMBAT corrosion the circulation of the boiler water should be stimulated. In addition the boiler should be thoroughly cleaned and a protective coating applied. The feed water, which is presumably softened or purified and has been analyzed if there is much evidence of corrosion, should be deaërated.

In any case the circulation should be studied; a surface which is scrubbed by rapid circulation is not so likely to become pitted as one on which the corrosive gases can lie and form a bubble. Of course, if the boiler duty be so lowered that any "fire" surface condenses the moisture of combustion, external pitting may result.

JOHN STEVENSON.
Los Angeles, Calif.

STEEL BOILERS used for heating purposes will corrode more rapidly than when used for power. This is due primarily to air and not to temperature.

A steel boiler used for steam heating is unable to discharge all the air contained in the water, because of the low operating pressure and the fact that air is heavier than steam. This air clings to the tubes and shell in bubbles. A chemical action causes the metal to waste away, leaving a pit where the bubble had been.

Air continually finds its way into the boiler either through air valves when a vacuum forms due to fires being banked or through leaky pump packing.

In addition to the pitting action from air, there is also pitting from acid of various kinds that find their way into the boiler through feed water.

Pitting action can be stopped or, at least slowed up, by treating the water with chemicals; soda ash is one of the easiest and cheapest to use.

I know of a plant that uses a horizontal tubular boiler for hot-water heating of buildings. Because all air is expelled from the system and make-up water is of good quality, the internal condition of shell and tubes is excellent. However, due to the low operating temperature of water, the boiler had a tendency to sweat. The moisture, mixing with sulphur distilled from fuel, caused external corrosion. This has been corrected by installing a bypass between the outlet and return pipes, which allows them to keep the water in the boiler at higher temperatures.

Stratford, Conn. M. C. NYE.

Furnace and Fuel Feeder Design For Burning Refuse

By M. A. HOFFT
President, M. A. Hofft Company
Indianapolis, Ind.

Moisture content, fineness of major fuel and kind of auxiliary fuel are important factors in the burning of refuse. This abstract of a paper presented at the fifth National Wood In-Industries meeting, New York City, discusses their influence on furnace, feeder and grate design.

THE PROBLEMS of refuse fuels are usually visualized as the burning of dry wood refuse with a moisture content varying from 6 to 10 per cent. However, engineers are often expected to provide for the burning of fuels having a moisture content as high as 65 per cent, contained in such unusual fuels as bark from paper mill logs, tanbark, sugar mill refuse, refuse from brush making and wet coffee grounds from commercial percolators.

Dry refuse-burning furnaces are of two principal types: one for burning finely hogged dry wood and sawdust in suspension, and the other for burning refuse partly in suspension, but mostly on inclined grates.

The burn-in-suspension furnace requires finely ground refuse that is fed mechanically at a uniform rate, and never blown in from a cyclone. This type of furnace is used in extensive woodworking plants where usually there are other boilers for burning an auxiliary fuel, or where the auxiliary fuel, if burned in the same boiler with wood, is pulverized coal, gas or oil. Raw coal, blocks, sticks and rubbish cannot be burned in this type of furnace.

The burn-in-suspension furnace is rather expensive, requiring high boiler setting, with sufficient vertical distance to burn practically all of the fuel before it drops to the floor of the setting, and a large furnace volume for suspension burning, at least as large as is required for pulverized coal for the same rating.

Maintenance of the refractory walls has been a big problem, due to the high furnace temperatures, and possibly to the erosion caused by the larger particles of fuel, which drop part way to the bottom of the furnace and are picked up by the draft and carried back up to the boiler. Air-cooled hollow-wall settings improved the conditions materially. For some time after the development of the burning of dry wood in suspension it was thought that water-cooled walls could not be used because they would reduce the furnace temperature to the point where the refuse would not burn completely before dropping to the floor.

Water walls, however, have been applied to the burn-in-suspension furnaces, as indicated in Fig. 1. This furnace, in addition to having water walls, has a hollow floor with air inlets to eliminate the piling of partly burned refuse on the floor. It will be noted that the boiler was set sufficiently high in relation to the roof of the furnace to force a longer travel of the fine particles before passing the first baffle of the boiler. I believe that this furnace could be further improved by the introduction of air jets at high velocity through the nose of the arch. These small air jets would still further prevent carrying over and would cause additional turbulence.

Sawdust, shavings and hogged dry fuel are fed from the storage bin by an automatically controlled screw feed. Instead of the fuel being delivered by the screws directly into the furnace, with charges of approximately a cubic foot of refuse per turn of the screw, it is fed from the screw through a rotary feeder. The rotary feeder breaks up these comparatively large charges of fuel into a fine spray, thus allowing intimate contact of air and fuel for complete combustion while in suspension. This arrangement prevents the introduction of cold air at the feed spouts, and is a factor in the success of the water-wall setting, as it helps to maintain a higher furnace temperature. It also eliminates puffing of the furnaces and possibility of backfiring into the bin.

The plants in which the burn-in-suspension furnace can properly be used are limited. Most woodworking plants are not large enough to afford these settings and the equipment necessary for supplying the auxiliary fuel. Further, they must be able to burn blocks, sticks and rubbish in case anything happens to the hog. There are also many plants where the moisture content of the fuel may be too high or the hogging too coarse for burning in suspension.

The inclined-grate furnace does not require such large furnace volume, as only the fine dust burns in suspension, the larger particles burning on the grate, producing excellent results, even in low-set boilers. Fig. 2 illustrates the setting for a 5,000-sq.ft. boiler, which has operated a large part of the time at 300 per cent rating. Much of the maintenance cost on this type of setting, when operating at a high rating, is in repairs to the bridge wall. Water bridge walls have been installed with excellent results, holding down the furnace temperature slightly. Water-

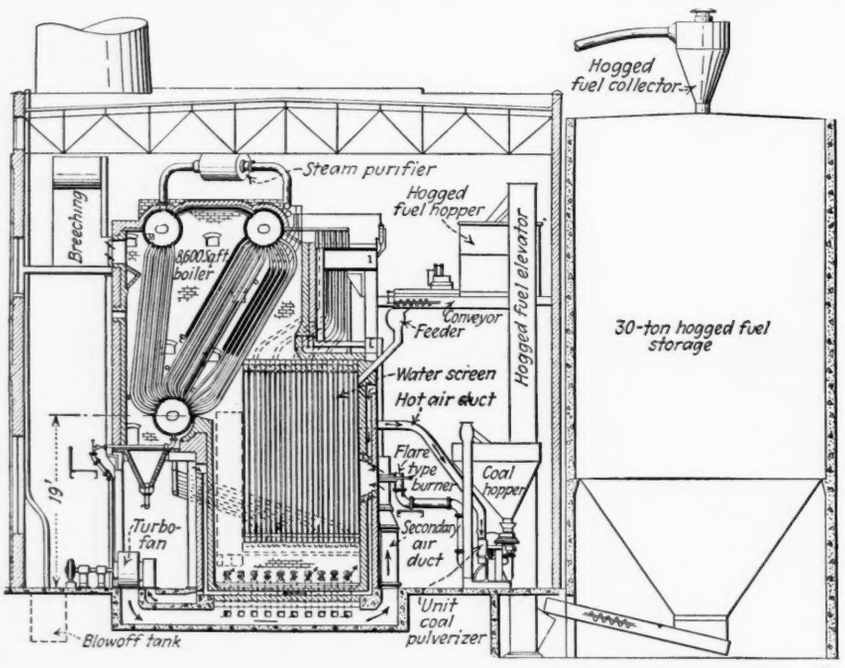


Fig. 1—Water-wall furnace designed to burn wood refuse in suspension

cooled side walls would be desirable, and would eliminate the maintenance on these refractories. The furnace has a volume of 1,280 cu.ft., or 2.53 cu.ft. per square foot of heating surface.

When this type of furnace is run at high ratings it is necessary to introduce extra over-air, especially when being fed with automatic feeder, as there is then little air admitted with the fuel. Over-air is introduced through the firedoors. Air admitted in this way is forced by the arch to mix with the gases before coming into contact with the boiler, so there is no appreciable loss in efficiency. When resinous woods are used for fuel the boiler will smoke at approximately 12 per cent CO_2, but oak and similar wood refuse may be fired with a higher CO_2 without smoke.

ALTHOUGH it is not desirable to set a boiler low, and a good furnace volume is desirable, it is possible to secure smokeless and efficient results with a low setting and restricted furnace volume. With the proper arrangement of arch smokeless operation has been secured at 200 to 250 per cent rating when the furnace volume was 1.67 cu.ft. per square foot of boiler heating surface. The arch should be constructed so that it forces the fine dust and gas distilled from the fuel deposited at the top end of the grate to pass down over the hotter fuel bed and to mix with the thinner gas at the lower end.

The grates are longitudinal and stationary, and for dry wood are inclined approximately 30 deg. There are no moving elements in the upper end of the grate. The air spaces at this point are horizontal, so as to prevent sifting of fine fuel into the ashpit. The lower section of the grate is provided with two to six rows of fuel pushers, depending on grate length. Each row of pushers is individually operated from the front by a separate lever. Since the upper grates are longitudinal and stationary, there are no projections or cross-ridges to hold up the fuel, and refuse fuel deposited at the top slips slowly down the grate as it burns, avoiding the necessity of shoving the fuel down the grate.

In burning refuse fuel it is objectionable to agitate the fuel bed, especially at the upper end. Agitation is eliminated with this type of grate, and with proper angle the fuel does not avalanche and pile up at the bottom.

There are dumps at the lower end of the grates for the removal of ash. The cleaning of the fire is accomplished by raising the lower row of pushers operating between the stationary grates and dropping the dumps.

The raised lower row of pushers prevents the slipping of good fuel into the ashpit, and at the same time kicks off the ash and clinker through the dump opening. When clean wood refuse is being burned the cleaner and pusher operation is only occasional, usually once in several days.

If it becomes necessary to use coal for the auxiliary fuel, the coking method of firing and the arch construction, which forces the volatile to travel down over the fuel bed, will make a practically smokeless fire, even with a high-volatile coal. But it is best to fire coal and wood refuse separately. When firing both at the same time the temperature created by the burning wood on top of coal will fuse the ash and cause heavy clinkers, unless the coal has a high-fusing ash.

The result from any refuse-burning furnace largely depends on the feeding method. With the old method of feeding, sawdust and shavings were blown

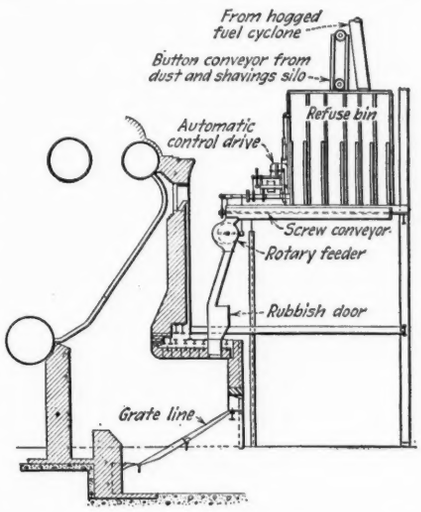


Fig. 2—Furnace arranged to burn wood refuse on inclined grates

from a cyclone directly into the furnace as they were made in the factory, regardless of the needs for steam. The furnace would be loaded with shavings at one time and in a few minutes it might become necessary to put in coal, often the cyclone blowing in only cold air. This led to equipment for regularly feeding the refuse to the furnace.

The early problems of this method of feed were, first, the fire risk caused by possible backfiring and puffing of the furnace; second, arching of the fuel in the bin. The first problem was overcome by the use of a rotary feeder between the end of the feed screw and the furnace. This made an effective air seal, keeping any backdraft and any sparks and backfire from getting into the bin. It also effectively breaks up the comparatively large charges of fuel delivered by the screw, spreading it more evenly in the furnace.

The second problem, the arching of fuel in the bin, was overcome by the use of a bin with a flat steel bottom and either vertical or slightly tapering sides. The bottom is provided with collecting screw conveyors.

Automatically controlled screw feeders are not well adapted to burning wet refuse, as the quantity of fuel to be handled is very great and heavy, and there is no fire risk in connection with its handling. The class of fuel can be handled with much lower cost and as satisfactorily with an ordinary drag conveyor in which the control of the feed is accomplished by controlling the depth of the fuel on the grate.

In the design of furnaces for burning these widely varying fuels, moisture content is the first consideration. The heat value of the fuel, size of the fuel particles delivered to the furnace, freedom with which the fuel burns, tendency to pack densely on the grate, draft conditions and capacity desired are a few of the factors that enter into furnace design.

The angle of the grates for wet refuse varies from 30 to 50 deg. The length of the grates also is determined by the moisture content and rate of firing and width of the boiler setting. The depth of the fuel bed at the top end of the grate is governed by the nature of the fuel, coarse-ground wet hogged wood refuse requiring about 18 in. at the top, sawdust about 15 in. and other fuels varying up to bagasse, which requires about 3 ft. 6 in. of fuel at the top end, on account of its light and porous character.

With wet fuels it is necessary to have as much refractory surface as possible to dry out the incoming refuse, and to help drive out and ignite the volatile gas. In order to accomplish this it is advisable to use two or more furnaces for wide boilers. Boilers of 7,000 sq.ft. of heating surface and larger have been equipped with three furnaces per boiler, and settings are now being designed for 12,000-sq.ft. boilers, with four furnaces to the boiler. The multiple-furnace construction is obtained by building grates in sections and putting refractory division walls between the sections. This not only gives the additional refractory surface needed, but causes the fuel fed to the top end of the grates to spread evenly over the entire section. With this type of furnace construction it is possible to operate with one section of the furnace idle, or to burn one class of fuel on one section of the grate and another on the other section of the grate.

FOR burning fuels of exceptionally high moisture content the fuel is first dropped onto a refractory hearth which is set on an incline of 50 deg. The thickness of the fuel on the hearth is regulated by a gate, which once set need not be moved unless the class of fuel is changed.

With some fuels it is practically impossible to get sufficient air through the fuel bed, and provision is made for a large quantity of over-air or auxiliary air through air ports placed in both the front and rear faces of the bridge wall, and in the side walls above the grates. Air introduced through these openings gives the necessary turbulence to speed up combustion. The regulated fuel depth and control of the air permit of operation with 14 to 15 per cent CO_2.

The tendency, in recent years, in designing furnaces for industrial woodworking plants has been more to design the furnace to burn the major fuel with the highest possible efficiency, and in this way to reduce the auxiliary fuel to a minimum, and to use a furnace that is adapted also to the burning of the auxiliary fuel available.

Refrigerating Engineers Become Industrial-Minded

Departing from the usual program of papers dealing with machine design and theory, the American Society of Refrigeration Engineers' 26th annual meeting at Hotel New Yorker, New York City, Dec. 3 to 6, gave its chief attention to refrigeration application in industry, food storage and freezing problems, although offering enough on refrigerating theory to satisfy the less commercial members

REGISTRATION at the annual meeting of the A.S.R.E. at the Hotel New Yorker, New York City, Dec. 3 to 6, exceeded that in more prosperous years. Part of this increase was due to the excellent program of teas, luncheons and other entertainments arranged for members' wives. The first day was devoted to registration, followed by a program on cold storage and quick-freeze problems.

"Recent Application of Low Temperature Refrigeration," by Frank Zumbro, Frick Company, was the initial paper of the meeting. The author outlined the mechanical layout of the plant installed at Montezuma, Ga., to quick-freeze ripe peaches.

This plant, the author explained, employs both ammonia and carbon dioxide as refrigerants. The carbon dioxide operates at a low temperature, and the CO_2 gas delivered by the compressor to the condenser is liquefied by giving up its heat to evaporating ammonia. The ammonia, after evaporation, is compressed in a separate machine and condensed in a standard design of condenser. The CO_2 evaporator is a series of coils placed in a bunker above the tunnel through which the peaches are passed to be frozen by an air current forced across the coils by motor-driven fans. The author felt that air as the freezing medium is superior to the brine used in some contact freezes. In the plant described 0.024 tons of refrigeration is required per pound of peaches frozen per hour, or 288 B.t.u. The power required per pound is 1/10 hp. The CO_2 evaporator temperature is held at —55 deg. F. and the condenser pressure is held at 345 lb., with the ammonia evaporator pressure at 20 lb. A filter filled with flake asbestos keeps oil out of the CO_2 coils. The heat transfer rate in the CO_2 coils was estimated as 175 B.t.u., which was doubted by Prof. A. H. Woods, who felt that 75 B.t.u. is nearer the correct value The CO_2 condenser consists of six sheels, each containing 70 ½-in. tubes 18 ft. long, giving 66 sq.ft. per sheel. The temperature difference between the CO_2 and NH_3 is held at approximately 10 deg. F.

Defrosting, the author stated in response to a question by George H. Horne, is obtained by opening the tunnel doors. The same system is employed for ice cream hardening and it has been found that freezing at —35 deg. F. improves the cream quality, since the ice crystals are small.

The second paper at the Wednesday afternoon session was entitled "Factors Involved in Latent Heat of Foodstuffs," being presented by Prof. W. R. Woolrich, University of Tennessee. It consisted, in the main, of tables giving the latent heats of fusion for various foodstuffs. One interesting point brought out by the author was that the latent heat consists of the latent heat of the moisture content of the foodstuff. For example, if a pear has 50 per cent moisture content the latent heat is $\frac{1}{2} \times 144 = 72$ B.t.u. Freezing points were given for many foods, but the author expressed doubt that a food has a fixed freezing temperature; rather there is a freezing temperature range, so that a food that shows signs of freezing at 28 deg. F. may not be entirely frozen until 0 deg. F. is reached.

SOMEWHAT the same belief was held by Paul Peterson in his paper on "Food Freezing Temperatures," embracing study of the ozmatic action in food cell membranes during freezing and attempting to explain why quick freezing does not result in large ice crystals.

The paper "Ozone and Cold Storage Foods," by Prof. A. W. Ewell, Worcester Polytechnic Institute, dealt with the protection offered by ozone against food spoilage.

IN HIS PAPER "Design of Float Valves" G. A. Wegner, of Wegner Engineering Company, expressed the belief that float valves are usually incorrectly placed in the flood system.

When the float expansion valve first made its appearance in connection with the so-called flooded system, the prevalent opinion among refrigerating engineers was that in a vertical freezing coil, as typified by the "Baudelot" cooler, the liquid refrigerant rose within the coil to about the same level as would show in the float-valve chamber. Therefore, the float valve was placed at some distance above the inlet pipe, anywhere from a half to three quarters of the distance between inlet and outlet, and it was assumed that the liquid would rise to the same height in the cooler.

It was also assumed that some ebullition would occur, and to take care of this there were the remaining pipes on top to act as a sort of dryer for what little liquid would be carried along by the outgoing vapors.

These assumptions, however, did not prove to be correct. The theory holds good, and then only partly so, in cases where a constant suction pressure can be maintained and the distance of the float above the inlet pipe has been properly spaced. A change in the suction pressure brings about different results. A rising suction pressure lowers the so-called liquid level, and some of the top pipes become useless as heat-transferring media; while a falling suction pressure raises the level.

There have been instances, so the author stated, where, when the pressure was quickly and considerably lowered, the whole interior of the pipe coil became choked with liquid and the pressure in the coil rose anywhere from 5 to 15 lb. higher than the pressure in the main suction line.

As a result of experiments conducted with a small ice-making tank supplied with twelve 1½-in. pipe coils of the zig-zag type and each nearly 300 ft. in length, the author came to the conclusion that the short pipe runs, such as the herringbone type, are not an absolute necessity, for after installing a device he was able to hold the brine temperature to within 2½ deg. F. above the temperature of the ammonia vapors.

The arrangement consists, basically, of a separator placed at the outlet of the coils with a pressure-controlled drain leading back to the float valve at the bottom of the coil. Liquid leaving the coils is drained back into the float.

THURSDAY MORNING "Oil Refining Refrigeration" was the subject of a paper presented by J. M. Wadsworth. This dealt with the various types of equipment used in refinery dewaxing processes. Formerly, absorption methods were exclusively used, but now the compound compression system is favored.

In his paper "Humidity of Cold Storage," M. W. Browne pointed out that whenever the humidity content of the air is too low for perishable food products, deterioration starts, from the increased loss of moisture by the products, which causes wilting and shrinkage. If the humidity is too high, without proper air circulation and humidity control, moisture will deposit, making conditions most favorable for the growth of mold and bacteria. This can be eliminated through the scientific application of mechanical air circulation and humidity control, as mold or bacteria will not thrive where the air is properly circulated.

Air conditioning within refrigerated rooms is the science of mechanically controlling the temperature, the humidity. and the movement of the air. It has been established that humidity cannot be maintained without proper mechanical air circulation and uniform unvarying temperatures throughout all parts of the room. These results are not possible under gravity air circulation, because the air gravitating from the refrigerant pipes to the floor level moves too slowly and sluggishly to take up the heat and moisture rising from the products at the time they are placed in the cold storage room. This causes the accumulation of excessive moisture to become mixed in the air and stratify in the upper levels of the room, dew-drops forming on the ceiling, which, in turn, fall to the floor and upon the products, resulting in mold and early deterioration.

The removal of moisture from the air for refrigerated rooms is accomplished by bringing the temperature of the air below the dew-point. Through the application of forced air circulation and humidity control it is possible to obtain and maintain the moisture content of the air required to keep fresh food products in reasonably prime condition. Success depends upon the quality and condition of the products at the time they are placed in cold storage; proper, even temperatures; correct relative humidity; and pure, clean air circulation, evenly and uniformly distributed throughout all parts of the cold storage room.

Dry ice was the subject of the paper, "Manufacturing Carbon Dioxide Ice," by C. O. Dueval, who discussed the processes and economics of dry ice manufacture and application.

FRIDAY MORNING'S SESSION opened with the paper "Intermittent Absorption Machine," by D. F. Keith. This was essentially a description of the "Icyball" portable refrigerating machine. It consists of two spherical containers, one of which acts as the generator inside the ice box and the other, containing weak liquor, is the absorber. The capacity of the units is small, but it should fill a need in rural communities where gas or electricity are not available.

H. R. Van Deventer's "The Inclosed Motor Compressor Patent Situation" was a résumé of the various basic patents on household machines.

Other papers at this session were "Commercial Machine Test Codes," by John Wyllie, and "The Determinations of Evaporation Capacity," by L. A. Philipp, both dealing with household machines.

AT THE joint session of the A.S.R.E. and A.S.M.E. Friday afternoon Prof. W. R. Woolrich presented a paper on "Effect of Humidity on Heat Transmission of Black and Galvanized Pipe." According to the author, tests on cooling hot water by passing warm air over the pipe confirm Allen's theory that the heat-transfer rate is less at high humidities than at low humidities, but this will only hold true when the air passing over the transfer surface is going from a cold state to a warmer state in circulating over the surface. In other words, when the air passes from a cold condition over a pipe that is at a higher temperature the air in the region immediately around the pipe will be increased in temperature without any increase in absolute humidity and this heating process will lower the relative humidity of the air.

Since dry air at temperatures above 20 deg. F. has a greater weight per cubic foot than saturated air, the effect of this greater density is to give a higher heat-transfer rate at lowest humidities. But when the cycle is reversed, and the warm air is passed over a cold transfer surface, the heat-transfer rate increases with the humidity after the dew point of the mixture has been passed in the area surrounding the heat-transfer surface.

Galvanized pipe, so the author stated, has a higher heat transfer coefficient than has black pipe.

ALTHOUGH the final session was held Saturday morning, almost all those registered Wednesday were present to listen to the several papers, the first being by M. R. Van Dusen and J. L. Finck, United States Bureau of Standards, on "Heat Transfer In Refrigerators." The authors claimed that it is possible to determine the heat transfer in a refrigerator as closely by computing the conductance of the wall material as can be obtained by a test run. Among other facts offered was that the resistance of an air space reached its maximum at $\frac{3}{4}$-in. In addition, the longer the air space the less the loss of heat per square foot of surface. Still another statement of the authors, radically different from accepted ideas, was that the resistance of several layers of insulation was no greater than that of a single sheet of the same total thickness.

In his paper "Thermal Testing," H. W. Eagle, of the General Electric Company, outlined the method his company follows in testing refrigeration. Reversing the actual action in a box, heat is introduced into the refrigerator while the inclosing room is kept at a low temperature. The author claimed that this gives results consistent with those obtained by the ice-melting test.

As the American Standards Association and the American Society of Refrigerating Engineers have proposed different testing codes for household machines, C. R. Roe, of the Electric Testing Laboratories, gave the results of tests conducted under the two codes. The author stated that the A.S.A. code gave more consistent values.

Smoke Reduces Light 21.5% in New York

A REPORT recently issued by the United States Public Health Service describes in a study of the loss of light due to smoke on Manhattan Island, New York City, during the year 1927, especially in its relation to the nature of the weather, the relative humidity of the air and the velocity and direction of the wind.

The presence in the air of soot and ash and appreciable amounts of sulphuric acid and other impurities results in economic loss and is a detriment to health.

Since the injury to health is due, in part, to the loss of daylight, and since the loss of daylight is a measure of the smokiness of the atmosphere, it seemed desirable to determine, so far as possible, the exact amount of light lost because of smoke in a large city in different seasons of the year and at different hours of the day; and also the extent to which the loss of light is affected by the height, shape and density of the smoke layer, the humidity of the air and the velocity and direction of the wind.

The study in New York City was made on the roof of the United States Marine Hospital at 67 Hudson St., at the lower end of Manhattan Island, where the air was unusually smoky, and on the roof of a building at the United States quarantine station on Hoffman Island, in lower New York Bay, about 9 miles south of the hospital, where the air was comparatively clear. The instruments used consisted of photo-electric cells and recording potentiometers.

The photo-electric cell was placed on the roof of the building where the study was to be made and the recording potentiometer was placed in a convenient position within the building. The platform was of such height that no shadows were cast upon the cell at any season of the year, and was so constructed that the cell's glass surface was accessible for cleaning. The cell at Hudson St. was about 79 ft. above the street level and 93 ft. above mean high water. The cell on Hoffman Island was about 35 ft. above the ground and 40 ft. above high water.

Comparison of the results obtained at the two places showed that there was a large relative loss of light at the Hudson St. hospital due to smoke. In some cases the average hourly or daily loss was greater than 50 per cent. The average percentage loss for the whole year was 16.6 for clear days, 34.6 for cloudy days and 21.5 for all days. The results showed that the loss of light depends, among other things, upon the altitude of the sun, the nature of the daylight (whether from a clear or a cloudy sky), the relative humidity of the air and the velocity of the wind.

Non-Ferrous Alloy Metals At Elevated Temperatures*

THE QUESTION of the behavior of metals when subjected to sustained loads at elevated temperatures is one that is receiving a great deal of attention at the present time. To date, however, a large share of the published work has been concerned with the behavior of ferrous alloys, or of non-ferrous alloys of the chromium-nickel type. This paper recorded the results obtained from non-ferrous alloys of the copper-zinc, the copper-zinc-tin, the nickel-copper, and the nickel-cobalt-titanium series.

The work on these alloys was undertaken because it was felt a great need existed for this type of information. Many of these alloys find wide use at slightly elevated temperatures in such applications as valve fittings, while others are used in tubular form at even higher temperatures. Each will render satisfactory service at temperatures up to a certain maximum, provided the proper balance is maintained between temperature and stress.

Experimental work in this investigation consisted of short-time tensile tests at normal and elevated temperatures, determination of lowest temperature of recrystallization by means of hardness tests, and metallographic examination and long-time creep tests at selected elevated temperatures.

Results obtained allow certain conclusions regarding the effect of temperature, mechanical working and chemical composition upon the short-time tensile and creep characteristics of certain non-ferrous alloys. The effect of chemical composition and the temperature of recrystallization was also determined.

In so far as the temperature of recrystallization is concerned, the alloy series arrange themselves in the order of decreasing temperature as nickel-cobalt-titanium, nickel-copper, and copper-zinc alloys. Of the copper-zinc alloys, those containing 70 per cent or more of copper have a higher range than those containing 60 per cent.

The short-time tensile tests show the high-nickel alloys to possess the maximum strength over the entire temperature range, with the Konel metal being the outstanding member of this group. With the remaining alloys, the cold-worked materials possess the greatest strength at the lower temperatures, but their superiority decreases with increasing temperature, and at temperatures at which marked recrystallization can occur their properties are comparable to those of the hot-rolled alloys. The strength of the alloys containing 60 per cent of copper falls off at a more rapid rate with increasing temperature than do those containing 70 per cent or more of copper.

The ductility of each of the alloys tends to decrease with increasing temperature. In the case of the cold-worked materials, however, this decrease is interrupted at the temperature of recrystallization. At this point a sharp increase occurs, which is again followed by a decrease with rising temperature.

Creep results again show the high-nickel alloys to possess the maximum load-carrying ability at all temperatures and to be capable of use at higher temperatures than the copper-base alloys. The Konel metal possesses the greatest load-carrying ability at 1,000 deg. F. of any material of which the authors were aware.

On the basis of these results the maximum safe working temperature for certain of the alloys when appreciable stresses must be withstood are believed to be as follows: Konel, at least 1,000 deg. F.; Monel, 800 deg. F.; copper-zinc-base alloys with 70 per cent of copper, 400 deg. F.; copper-zinc alloys with 60 per cent of copper, 300 deg. F.

Concerning the relationship between the lowest temperature of recrystallization and creep characteristics, it was observed that at temperatures below the lowest temperature of recrystallization loads of appreciable magnitude do not produce continuous flow, while at temperatures above, continuous flow is obtained with any load regardless of its magnitude.

In the discussion, J. J. Kanter, of Crane Company, referring to rolled Monel metal, pointed out that much higher strength and elasticity at elevated temperatures than the authors reported could be obtained on cold-drawn material. If the object of using Monel metal is high strength, the foregoing properties should recommend it. The strength of cold drawn Monel, nearly 60,000 lb. per square inch at 1,000 deg. F., is second only to that of Konel metal. The reduced elongation and reduction of area characterizing these nickel alloys is shown by the Crane tests also to occur in pure nickel. This tendency toward brittleness is greatly alleviated at 1,200 deg. F., indicating the minimum points of the ductility temperature curves occur in the vicinity of 1,000 deg. F. Mr. Kanter also discussed the change in the tensile properties of wrought brasses and bronzes during fabrication, the proportional limits of dead annealed brasses, and types of fracture that are obtained on high-temperature tensile-test specimens.

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Comparative Physical Properties Of Austenitic Steels*

WITH the advancing trend in operating temperatures in many industries, the need for metals to successfully withstand not only the necessary stresses but also the oxidizing atmosphere is becoming more pronounced. Up to a certain maximum, 1,000 or 1,100 deg. F., the so-called pearlitic steels may be successfully used. Certain of them, when in the proper heat-treated condition, possess remarkable strength at the higher temperatures and are able to resist to the necessary extent the corrosive action of the gases with which they are in contact. For temperatures much above 1,000 deg. F. the effect of any beneficial heat treatment is largely lost, and the strength of all pearlitic steels decreases rapidly. In this temperature range the austenitic steels display superior characteristics both in regard to load-carrying ability and resistance to oxidation. The dividing line between these two zones is not definitely marked, and in certain applications pearlitic steels can be used above 1,000 deg. F., and in many austenitic steels are used below 1,000 deg. F.

The types of austenitic steels commonly used for high-temperature service are not diversified, commercial practice confining itself almost completely to those chromium-nickel steels known as Enduro KA2. On the basis of present knowledge, the confinement to this particular series of steels is not unwarranted, for they do possess the outstanding properties for the majority of applications. These steels, however, also possess certain undesirable characteristics, and substitute steels, free from these disadvantages and yet possessing the valuable properties of Enduro KA2, would be highly welcomed. Whether or not certain other austenitic steels would fulfill these conditions is unknown, at least from the information available.

The work reported in this paper was undertaken to determine the effect of certain changes in composition upon the physical properties of steels of the Enduro KA2 type; also to ascertain the truth of the statement sometimes made that all austenitic steels should exhibit nearly the same properties at high temperatures, regardless of the alloying elements present. The investigation was extended to include a straight 14 per

*Abstracts of papers presented at annual meeting of the American Society of Mechanical Engineers by C. L. Clark, assistant investigator, Department of Engineering Research, and A. E. White, professor of metallurgical engineering and director of the Department of Engineering Research, University of Michigan.

cent manganese steel, and a 14 per cent manganese, 1 per cent tungsten steel.

Alloys investigated belong to either the chromium-nickel, the chromium-nickel-silicon, the chromium-manganese-silicon, the manganese, or the manganese-tungsten series.

Temperatures chosen for the comparison of the tensile characteristics of these steels were room temperature, 75 deg. and 1,000 deg. F. The experimental work consisted of short-time tensile tests at each of these temperatures, and long-time creep tests at 1,000 deg. F.

Results obtained from the short-time tensile and long-time creep tests allow certain conclusions to be drawn regarding the effect of composition, fabrication, and heat treatment on the high-temperature characteristics of the selected steels.

In so far as the short-time tensile properties at room temperature are concerned, the substitution of manganese for the nickel in the Enduro KA2 type of alloy results in a slightly increased strength and greatly decreased ductility. The tensile strength increases with the manganese content, while the proportional limit decreases. Specimens of the chromium-nickel alloy taken from tube stock display less strength and greater ductility than those from the bar material. Whether this material is water-quenched or hot-rolled makes no appreciable difference in the strength properties, but does greatly affect its ductility as shown in the percentage of elongation, the quenched material possessing much higher values. The manganese steels proved to be extremely brittle.

The short-time tensile properties of the material at 1,000 deg. F. arrange themselves in approximately the same order as at room temperature. The two straight manganese steels possess a good degree of ductility at this temperature, in fact, superior to that of the chromium-manganese alloys, and comparable to that of the hot-rolled KA2.

CREEP results at 1,000 deg. F. indicate that the chromium-nickel alloy from the bar stock has greater load-carrying ability than that from tube stock and that the water-quenched material is slightly superior to the hot-rolled material. Also that the substitution of the nickel with manganese has produced a marked lowering in the material's ability to withstand continuous stress. The 14 per cent manganese steels possess properties comparable to those of the chromium-manganese steel, while the addition of tungsten was found to increase its resistance to a marked degree.

Prof. F. H. Norton stated that the results given by the authors verified a previous statement of his to the effect that all austenitic steels were in a separate class in regard to resistance to creep at high temperatures. The authors showed that all these steels have a creep resistance of 8,000 to 12,000 lb. per square inch for a 1 per cent elongation in 100,000 hr. at 1,000 deg. F., which may be compared with a resistance under the same conditions of only 3,000 or 4,000 lb. for carbon steel. At higher temperatures it is even more marked. It would be most interesting, said Professor Norton, if the authors continued the work on these steels up to higher temperatures, to determine whether the various austenitic steels would show the same similarity.

J. J. Kanter pointed to the fact that results from the Crane and University of Michigan laboratories were in fairly good agreement on similar grades and conditions of materials. A notable peculiarity brought out by Crane results is that the proportional limits shown by the water-quenched specimens in general are considerably less than those given by the hot-rolled and hard-rolled conditions. The tensile properties of austenitic steels in the various conditions and treatments to which they are responsive apparently obey the same rules that have been found to apply to other types of steel. Fine grain size at the lower temperatures is conducive to high strength and elasticity. At extremely elevated temperatures large grain promotes creep resistance.

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Steam-Table Experts Announce Further Progress

IN RECENT years American engineers have added much to the world's knowledge of the properties of steam. The work, started with simultaneous projects at Massachusetts Institute of Technology, Harvard University and the United States Bureau of Standards, was supported by money raised through the efforts of the A.S.M.E. special research committee on the thermal properties of steam. The Harvard experiments were completed some years ago. While those at M.I.T. and the Bureau of Standards continue, the data already supplied have kept up with the growing needs of the profession.

In the summer of 1929 an international skeleton table of steam table values and tolerances was agreed upon at a London conference of steam research experts from England, Germany, America and Czechoslovakia.

Each year the American committee meets at the time of the annual A.S.M.E. meeting in New York. The following brief report of this year's session was omitted, for lack of space from the general A.S.M.E. report in the Dec. 9 number of *Power*.

As in former years, the session was notable for the presence of men whose scientific capabilities and continued effort have produced such remarkable results in the accumulation of precise steam-table data and in their formulation.

Arthur M. Greene, Jr., Dean of Engineering at Princeton, presided. With him sat George Orrok, in a sense the father of the present movement and its consistent backer. Harvey N. Davis was present—president of Stevens Institute, but still a physicist noted for his grasp of steam-table problems and for his ability to describe and explain in language of crystal clearness.

At the meeting were the men whose personal labors have built an imposing body of data: F. G. Keyes and L. B. Smith of M. I. T., N. S. Osborne of the U. S. Bureau of Standards, Professor Keenan, who translated research results into the steam tables recently published by A.S.M.E. Professor Marks of Harvard was there, as were Doctor Kleinschmidt, former steam investigator worker at Harvard, Professor Heck of Rutgers and Professor Stuart of Lehigh.

At the start of the meeting Mr. Orrok reported that the financial situation is well in hand. Doctor Smith discussed new volume measurements made at M.I.T., using bombs of special alloy steel to cut down corrosion and resulting error. Doctor Keyes predicted the publication of a final table of vapor pressures in February. He said it would be possible to give a complete table of the volume of saturated liquid from 100 deg. C. to the critical point. At the same time information will be given out on the compression of water by pressures above those of saturation. Professor Keenan pointed to the growing importance of the compressibility of liquid water. Negligible at low pressure, this becomes a real factor in high-pressure plants, and affects computations made for the feed water system.

Several speakers voiced the thought that information on the viscosity of steam at high pressures and temperatures would be helpful in the design of modern power plants.

N. S. Osborne of the Bureau of Standards presented additional values of latent heat and described the design of a new type of calorimeter to work up to the critical point.

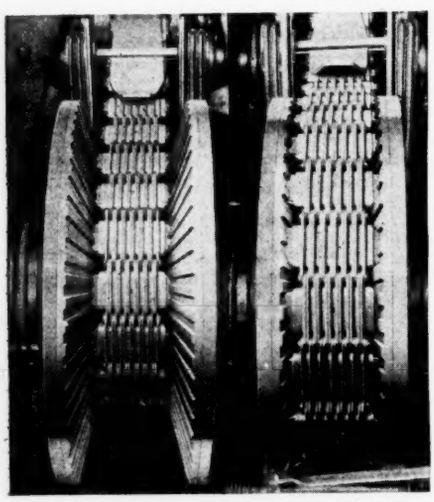
Dr. Davis summed up the steam research conference held at the end of the World Power Conference in Berlin. He said that the international skeleton steam table of the year before was again revised to points more nearly representing the average of figures presented by the various delegates. This revision awaits final approval and release, he said.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

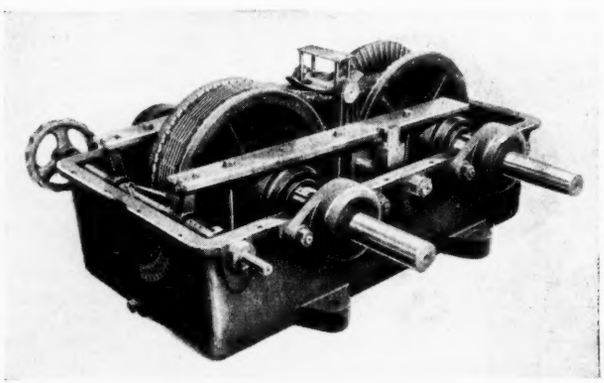
Positive-Drive Variable-Speed Transmission

AN all-metal infinitely variable speed transmission has been announced by the Link-Belt Company, of Chicago. It is called the P.I.V. gear, the initials standing for "positive infinitely variable," indicating its characteristics. Basically, this speed-change unit consists of two pairs of wheels of the opposed conical disk type, between which a chain transmits power. The effective diameters of each pair of wheels can be altered under load to change the speed ratio without steps and without dependence upon friction. On changing speed, the self-pitching chain rises in one set of wheels and descends in the other, so that while the input shaft connected to a motor or other source of power turns at constant speed, the output shaft is brought to the desired revolutions.



Tooth formation of chain on minimum and maximum diameters of a wheel

Variable-speed devices employing adjustable conical disks and belts with side friction contacts have been available for some time. The important feature of the new gear is its use of a positive chain drive to transmit the power. Radial teeth are cut in the conical faces of the driving disks, and the self-adjustable teeth projecting beyond the sides of the chain are arranged to positively engage the radial teeth of the disks.



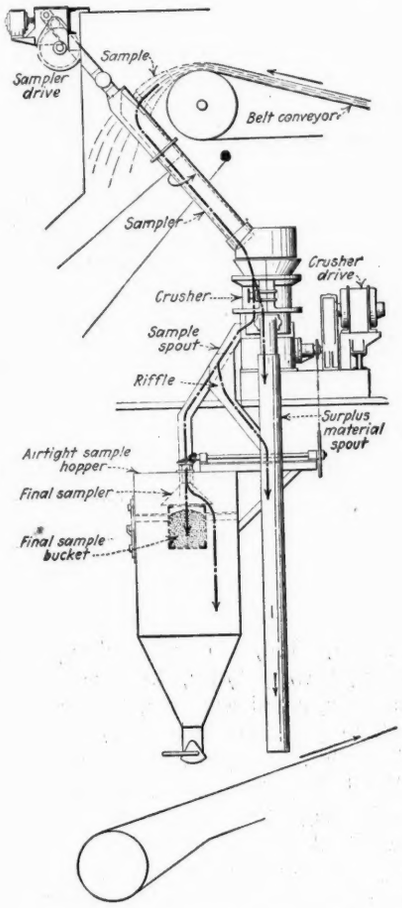
Link-Belt P. I. V. self-lubricating gear with cover removed

The chain is made up of a series of steel leaves or links with joints consisting of hardened steel pins turning in segmental bushings. There are no teeth on the inner surface of this chain. Instead, what may be called teeth are made up of packs of thin hardened steel laminations or slats which extend through slots in the links at right angles to them and project about $\frac{1}{8}$ in. at each side of the chain. The individual containers that hold the packs of slats are secured in the openings of the links, but within each container the slats are free to slide from side to side individually with relation to each other and adjust themselves to engagement with the radial teeth of the disks over substantially the full range of diameters. The angle of the slat ends, 30 deg., is the same as that of the conical faces of the wheels.

The teeth of the disks widen from the center outward toward the circumference, but are of uniform depth. They are so "staggered" relatively on each pair of wheels that the slats move back and forth into the teeth to mesh correctly as the chain comes into contact with the wheels. Self-pitching of the chain to any tooth width or wheel diameter is thus assured. At each engagement of the chain and wheels the slats are regrouped within their separate containers, but do not slide under working pull. Their movement in engaging with the wheels is complete before the load is applied.

All elements of the gear are built into, and protected by, a compact oil-tight housing, and are automatically splash-lubricated. The hardened-steel wheel faces are mounted on cast-iron hubs backed by ball thrust bearings, and move axially on the shafts, which, in turn, are mounted in radial ball bearings. The movement of the pairs of wheels together or apart, to increase or decrease their effective pitch diameters, is controlled by a pair of pivoted levers operated through a hand control shaft with right- and left-hand screw motion. Initial chain tension is provided for by an external adjustment screw, and correct operating tension is maintained at all ratio settings by two hardened shoes that ride lightly on both upper and lower strands of the chain, under constant spring pressure.

For the present the P.I.V. gear has been put into production in five sizes, from 1 to 10 hp. capacity, providing speed change ratios up to a maximum of six to one. The gear is a development of an earlier British design, a description of which appeared in the Nov. 9, 1926, number of *Power*.



Sampler receives coal from conveyor, crushes, quarters and puts sample in bucket suspended in air-tight compartment

Automatic Coal Sampler

IN THE Dec. 28, 1926, number of *Power* an automatic coal sampler designed by T. Thorsten, consulting engineer, Pittsburgh, Pa., was illustrated and described. Since the first installation of this sampler, which was made at the Springdale, Pa., power station, several improvements have been made to it and it is now being manufactured and distributed by the Charleroi Iron Works, Charleroi, Pa.

Among the important improvements made to the sampler since it was first introduced are, adoption of independent motor drive for the primary sampler, addition of a rotating final sampler, and the inclosing of the final sample bucket in an air-tight hopper. Briefly, the system consists of a primary sampler placed ahead of the head pulley of a belt conveyor, a motor-driven crusher for crushing the sample to the required fineness, a rotating final sampler and a final-sample bucket.

The primary sampler consists of a rotating tube placed approximately 90 deg. to the coal stream and having an opening in one side of sufficient length to take the full depth of the coal stream. By revolving the tube intermittently, samples are secured at predetermined intervals of one, two or three minutes and transported to the crusher. In the interval between the samples the sampler travels sideways across the stream a distance equal to the width of the opening in the tube. By being made to move back and forth across the stream in this way samples over the whole width of the stream are secured.

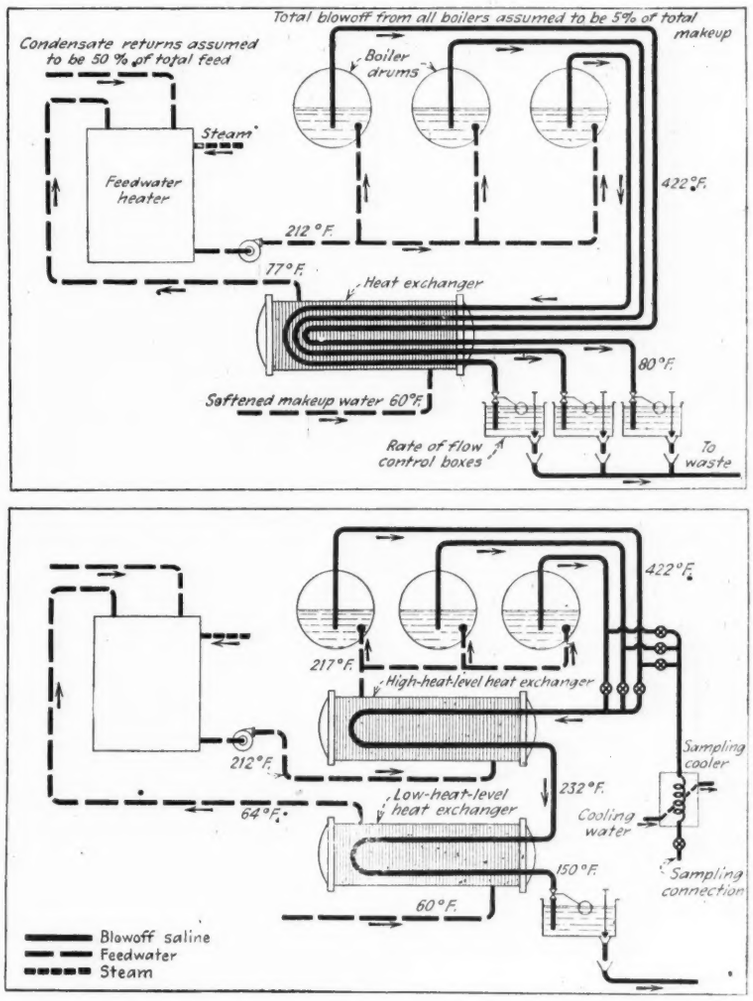
In the crusher the samples are crushed and mixed and 90 to 95 per cent of the material is discarded through the surplus material spout, the remaining 5 to 10 per cent passing to the final sampler. If desired this 5 to 10 per cent sample may be further reduced by the use of a standard riffle inserted in the spout as indicated on the drawing. The final sample is further quartered and reduced, so that after a day's run there remains in the bucket a sample of a size suitable for laboratory use.

The final sampler is located inside an air-tight hopper that receives the surplus material and retains it until the end of the operating period of the conveyor, at which time the bucket is removed from the hopper, sealed and sent to the laboratory for analysis. The surplus material in the air-tight hopper is then discharged to the conveying system.

Continuous Boiler Blowoff System

TO PROVIDE an automatic means of controlling the concentration in each boiler and recovering the useful heat contained in the blowoff liquid, the continuous blowoff system, shown diagrammatically in the accompanying illustration, is being offered by the Permutit Company, 440 Fourth Ave., New York City. Numerous system arrangements are available to meet various operating conditions.

The upper illustration shows a practical arrangement where there is insufficient waste exhaust steam available to raise the temperature of



Blowoff system arranged for individual and group blowoff control

the feed water to the boiling point in the open heater. This arrangement provides for automatic control of the blowoff from each individual boiler. It also permits the operator to determine immediately the condition of the salines discharged from any boiler at any time and to regulate the flow from each boiler accordingly. To provide this individual control a multiple-compartment heat exchanger is used. The blowoff line from each boiler connects to one of these compartments and a separate control box is used on the discharge of each compartment.

Where there is sufficient exhaust steam available to heat the feed-water to the boiling point in the open heater a heat exchanger is placed on the discharge side of the boiler feed pump, as shown in the lower view. In this arrangement the blowoff lines are combined in a single header and passed through the heat exchangers in a single stream.

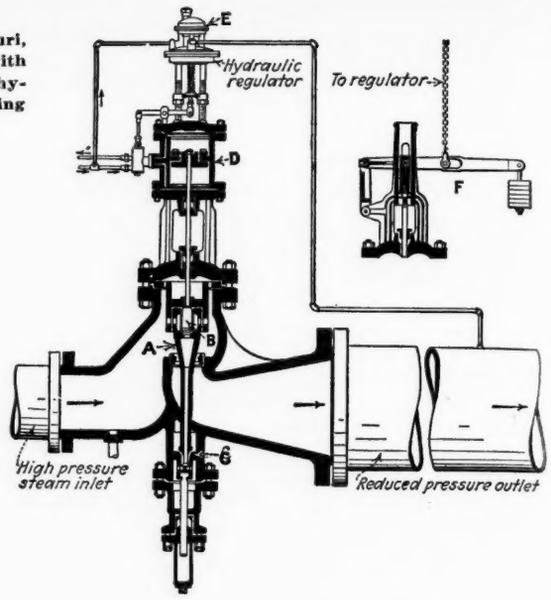
Control of the rate of blowoff is accomplished by a special rate-of-flow controller, consisting of an open box provided with a high-pressure float valve connected to the blowoff lines, which maintains a constant liquid level over a discharge orifice in the control box. The size of the discharge opening is adjusted by means of a needle valve equipped with an indicating dial.

Balanced Venturi Reducing Valve

THE ILLUSTRATION shows a single-seated balanced Venturi reducing valve now being put out by the Schutte & Koerting Company, Philadelphia, Pa. The valve is designed for working pressures from 250 to 450 lb., and to give accurate regulation with smooth flow of steam. A long tapered disk having a long travel regulates the steam passing through the valve and the outlet side of the valve body is made Venturi shape to allow expansion of the steam down to the specified reduced pressure.

To provide a balanced valve and reduce the power required to operate it, the disk *A* is made hollow and fitted with a pilot valve *B* through which the high-pressure steam reaches the lower side of the bottom piston *C*. Operation of the valve is by means of the hydraulic cylinder *D* under control of the regulator *E*.

Where a suitable regulator is already installed or where the regulator must necessarily be separated from the valve, a weighted lever is used, as shown at *F*. The valve can also be had arranged for electric motor operation. In this case it is fitted with a screw spindle and connected to the driving motor by means of a reduction gear, the current to the motor being controlled by a special electric pressure control unit. The valve is made in sizes from 2 to 12 in., inclusive.

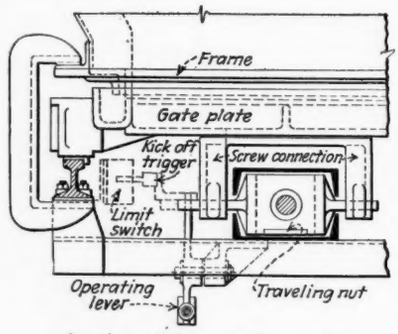


Section of Venturi, reducing valve with self-contained hydraulic operating cylinder

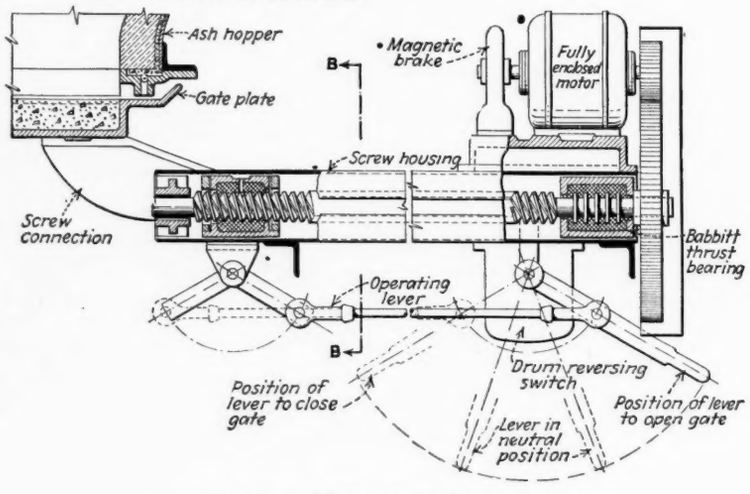
Electric-Screw-Drive Ash Hopper Gate

IN THE accompanying illustration are two views of the electric screw drive gate now being put out by the Beaumont Manufacturing Co., Philadelphia, Pa., in underslung and straight-away types, for use on ash hoppers, small ash cars, trucks, etc.

The gate-operating screw is driven through spur gears by a fully inclosed high-torque motor equipped with magnetic brake. A cast-steel babbitted nut actuated by the driving screw moves the gate as required. The nut is connected to the gate by a floating connection, which tends to eliminate binding between the gate and drive unit at all points of travel. To insure sufficient impact to start the gate under all conditions of load a gap is provided between the traveling nut and nut housing to permit the drive screw to come up to practically running speed before coming in contact with the nut housing. The end thrust of the screw is taken by a five-ring babbitted thrust bearing. The gate can be operated by standard push-button control through magnetic contactors or by a drive reversing switch with hand lever or pull cable.



Section of Screw Drive on B-B



Details of electric screw drive gate

NEWS of the FIELD

Spot News

THE LARGEST SINGLE-CYLINDER TURBINE *was placed in operation last week at the Charles R. Huntley Station of the Buffalo General Electric Company of Buffalo, N. Y. This generating unit is rated at 80,000 kw. and operates at 1,800 r.p.m. on steam of 435 lb. pressure and 750 deg. F. temperature. Another unit, similar to this, is now being installed in the station.*

IN AN EFFORT *to break the deadlock on Muscle Shoals legislation, House conferees on the bill offered compromises to the Senate conferees on Dec. 12, which provide for government operation of the dam and power station, completion of Cove Creek dam by the government, private leasing of the fertilizer plants and sale of surplus power at the switchboard, giving preferential purchase rights to states, counties and municipalities.*

THE DEATH SENTENCE *imposed on Prof. Leonid K. Ramzin of the Thermo-Technical Institute in Moscow, Russia, following his conviction for conspiracy to overthrow the Soviet Government, was commuted last week to ten years' imprisonment. Professor Ramzin, who is recognized in Europe as an outstanding authority on combustion, contributed three of the most brilliant papers read at the World Power Conference last June.*

DELIVERY *of 10,000 kw., the first power to be sold from the enormous Saluda dam hydro-electric plant near Columbia, S. C., was made last week to the Duke Power Company. Within a month it is expected that the plant will be producing its full output of 180,000 kilowatts.*

Timely Technical Program Announced for A.I.E.E. Winter Convention, Jan. 26-30

Industrial power applications, protective devices, welding, research and electrical machinery among subjects to be discussed at eleven sessions

AN EXTENSIVE PROGRAM of live topics has just been announced for the annual winter convention of the American Institute of Electrical Engineers, which will be held in New York City from Jan. 26 to 30, 1931. Papers on protective devices, power transmission, industrial power applications, electric welding, research, electrical machinery, telegraphy and transportation will be presented in eleven technical sessions representing the active progress of modern electrical engineering.

In addition, an interesting program of entertainment features is announced, which will include a smoker with special divertisements, the Edison Medal presentation and lecture, timely inspection trips and a brilliant dinner-dance.

At the protective devices session on Tuesday afternoon the following papers will be read and discussed: "Trend in Development of Modern Circuit Interrupters," J. B. MacNeill; "Philo 1930 Oil Circuit Breaker Tests: Aims, Set-Up and Results From a System and Operating Point of View," Philip Sporn and H. P. St. Clair; "Arc Extinction by Scavenging," D. C. Prince and W. F. Skeats; "Field Tests on Standard and Oil-Blast Explosion Chamber Oil Circuit Breakers," R. M. Spurck and H. E. Strang; "The Trend of Development in Metal-Enclosed Switching Equipment," M. H. Hobbs; "An Experimental Lightning Protector for Insulators," J. J. Torok; "Field Tests on Thyrite Lightning Arresters Using Artificial Lightning of 1,500,000 Volts," K. B. McEachron and E. J. Wade.

On Thursday morning a session on industrial applications will be held, at which the following papers will be presented: "Electron Tubes in Industry," W. R. King; "Automatic Regulators in Industry," J. H. Ashbaugh; "Electrical Distribution Systems for Industrial Plants," W. J. McLain; "The Synchronous Motor With Phase-Connected Damper Winding as a Drive for High-Torque Loads," M. A. Hyde, Jr.; "The Design and Application of Synchronous Motors to Meet Special Requirements," D. W. McLenegan and A. G. Ferriss; "Weather Making—A Public Service and a New Use of Power," D. C. Lindsay.

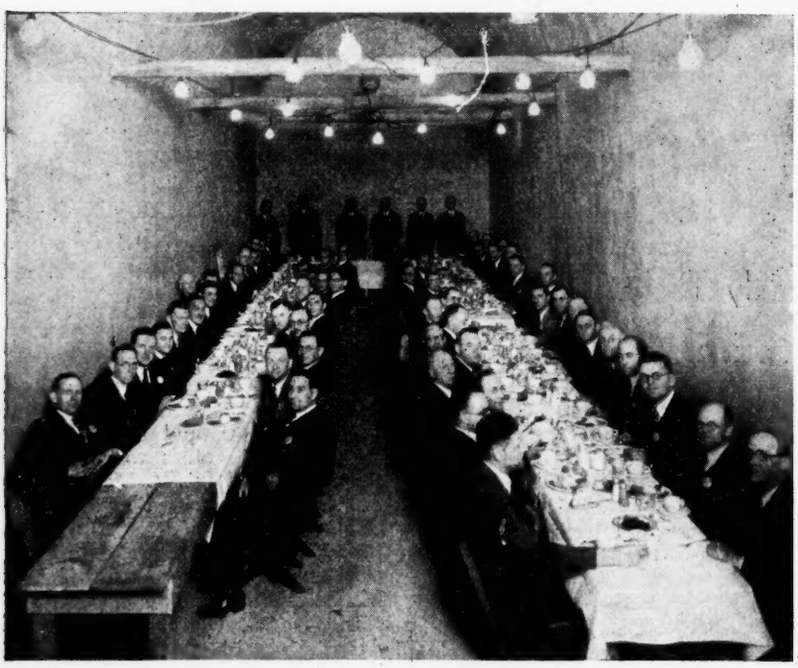
In the afternoon the following papers will be presented at the electric welding session: "Some Experiments With Arcs Between Metal Electrodes," G. M. Shrum and H. G. Wiest, Jr.; "An Improved Arc-Welding Generator," J. H. Blankenbuehler; "The Neutralized Welder and Its Applications," F. Creedy; "A System for Direct-Current Arc Welding," S. R. Bergman; "Resistance Welding of Motor Frames," Malcolm Thompson; "Electric Resistance Brazing," Samuel Martin, Jr.

Two sessions will be held on Friday, one in the morning on research and the other in the afternoon on electrical machinery. Papers to be given at the former include "Commutation and Current Collection in Hydrogen," R. M. Baker, and "The Helical Groove," G. M. Little. At the electrical machinery session the following papers will be read: "Mercury-Arc Rectifier Research," A. W. Hull and H. D. Brown; "Effect of Transient Voltages on Power Transformer Design — III," K. K. Palueff; "Stationary Flow of Heat in Large Turbine-Generators," C. Richard Soderberg; "Induction-Motor Slot Combinations," Gabriel Kron; "The Pulling Into Step of a Salient-Pole Synchronous Motor," H. E. Edgerton.

Line Trouble Causes Break In Staten Island Service

Conflicting versions have appeared in the daily press as to the disturbance on the system of the Staten Island Edison Corporation, which tied up traffic and left the island without lights for a period on Sunday evening, Dec. 7. For the benefit of those readers who have made inquiries concerning this service break, it may be stated that the trouble was due to a short circuit on one of the cables which did not clear immediately and not to the failure of any of the equipment within the power house itself.

P. G. & E. DINES IN A SMOKESTACK FLUE



SEVENTY OFFICIALS and employees of the Pacific Gas & Electric Company dined recently in a new smokestack flue of Station "A", the company's steam-electric generating plant in San Francisco, Calif., which is being reconstructed and its capacity increased from 85,000 hp. to an ultimate of 300,000 hp. Three 1,400-lb. boilers are being installed to drive two 70,000-hp. turbines. One of these new generating units is now ready for service, and the second is scheduled for completion next spring. Following that two larger units will be installed.

The "banquet hall" here shown is 55 ft. long, 18 ft. high and 17 ft. wide and leads from the fire box of one of the new boilers into a new smokestack 200 ft. high and 24 ft. in diameter. A second flue, 125 ft. long, serves the other two boilers.

Guests of honor at the dinner included Paul M. Downing, vice-president and general manager Fred George, engineer in charge of operation; W. G. B. Euler, superintendent of the San Francisco metropolitan district; S. J. Lisberger, chief of the division of electric distribution and steam engineering; M. C. McKay, assistant engineer of construction, who is in charge of enlarging Station "A"; Henry Bostwick, manager of the San Francisco Division; George Barr, General Electric Company, and others.

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Mandatory Use of Stokers Asked by Railway Firemen

Complaint has just been made to the Interstate Commerce Commission by two railroad enginemen's unions urging the Commission to require the railroads to equip their locomotives with mechanical stokers, and power reverse gears, alleging violations of the Boiler Inspection Act by reason of the operation of locomotives equipped with manual appliances. The complainant unions are the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen and Enginemen.

On behalf of the firemen, it was stated "that the use and operation of such locomotives without the same being equipped with mechanical or automatic means for feeding the coal or fuel into the fire boxes thereof endangers the health, safety, comfort and general welfare of the firemen by unduly exposing them to unnecessary and excessive fatigue in the performance of their duties."

In connection with the manually-operated reverse gears in use on many locomotives, it was said that such gears are "inherently improper, unsuitable, and unsafe in principle and design."

Commission Refuses License For New River Project

The Federal Power Commission has declined to issue a license for the New River power project and called for a court decision to unsnarl the tangled state and commission rights involved.

The Appalachian Electric Power Company had sought permission to build an $11,000,000 plant on New River near Radford, Va., but the commission found that legal opinions conflicted. Into the problem there entered the old question of whether the commission has jurisdiction over non-navigable streams. New River is considered such a stream, though flowing into one that is navigable. The commission said it was desirable that its position with relation to the states be determined and that a court ruling should be had to afford a precedent.

To settle the question, the commission announced, the Appalachian company could start work without the license and the federal agency could sue for an injunction, which would throw the matter into the courts for final decision. After a conference with Department of Justice officials, however, representatives of the company were not satisfied that they would be justified in starting construction on the project without license.

Nebraska Law Permits Instalment Buying

Purchase of power equipment out of income by municipal plants in Nebraska was authorized in a public ownership measure passed recently by a referendum vote of 240,579 to 89,205. Under this law cities and towns owning lighting and power plants may, provided that cost is paid out of net earnings, extend their lines beyond the corporate borders by vote of council and may pay for power plants and systems by pledging future earnings instead of by taxation. The law requires a 60 per cent vote of the people to sell a publicly owned plant, limits the expenses of elections called for that purpose and compels filing of reports of costs of plants to be sold.

By a vote of 155,107 to 144,595, the proposal requiring a vote of the people to make extensions or purchases was beaten. A third proposal, which permitted sale of plants by a majority vote, was beaten, 162,050 to 118,617.

Three municipal plants were purchased by power companies the week before the canvass was completed.

Oregon Cities Plan 297,161-Hp. Projects

Ralph C. Clyde, city commissioner-elect of Portland, Ore., has filed with the State Engineer five separate applications for as many permits to appropriate water from the Deschutes River for the purpose of developing 212,161 theoretical horsepower. Attached to the applications are waivers providing that, in the event of the grants being allowed by the state, they shall be issued in the name of the City of Portland and be used thereafter for municipal purposes, namely, the construction of public-owned and operated hydro-electric plants.

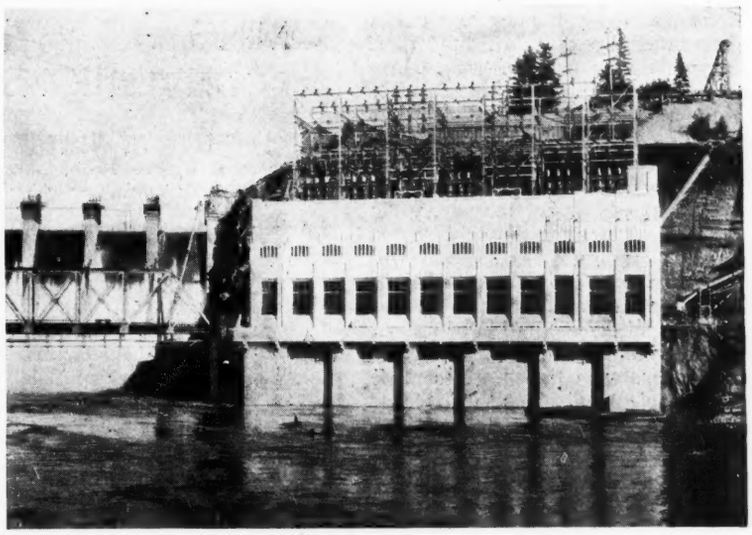
Structural plans accompanying the applications describe the proposed five projects as follows: Dam No. 1, 94 ft. high, developing 38,800 hp., cost $3,149,-

300; No. 2, 118 ft. high, developing 47,500 hp., cost $4,136,000; No. 3, 104 ft. high, developing 44,490 hp., cost $3,916,000; No. 4, 98 ft. high, developing 33,238 hp., cost $2,915,000; No. 5, 63 ft. high, developing 51,133 hp. cost $4,499,000.

David G. Glass, city engineer of The Dalles, Ore., has filed application on behalf of the city for permits to appropriate 9,000 sec.-ft. of water from the same river, the Deschutes, for the purpose of developing municipally-owned hydro-electric power in Wasco County. Description of the proposed projects did not accompany the city's application, other than the horsepower to be developed, which is estimated at 85,000 hp.

The state engineer has been informally advised that The Dalles application is probably the first step looking to the creation of a power district under the constitutional amendment approved by the people last November.

CANADA'S NEWEST HYDRO PLANT



View of Ruskin hydro-electric plant on Stave River, B. C., which went into operation last month. A part of the British Columbia Electric Railway Company's system, the new station adds 47,000 hp. to the power supply of Vancouver and adjacent cities

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Boiler Inspectors Wanted for Steamboat Service

Open competitive examinations for the positions of local and assistant inspector of boilers in the Steamboat Inspection Service have just been announced by the United States Civil Service Commission at Washington, D. C. Applications for these positions must be on file with the commission not later than Jan. 13, 1931. The entrance salary for local inspector is $3,200 a year; for assistant inspector, $2,900.

Competitors in the examination will be rated on (1) letter writing, (2) arithmetic, (3) boilers, engines, motors, machinery, and inspection, and (4) experience. Applicants for local inspector must have at least three years' experience in a responsible position on board a steam or motor vessel of certain specified gross tonnage; for assistant inspector the experience requirement is two years. At least one year of the specified experience must have been within the five years next preceding the date of applications.

Full information may be obtained from the commission in Washington, or from the secretary of the United States Civil Service Board of Examiners at the postoffice or custom house in any city.

Cleveland Chamber Starts New Inventors' Service

Inventors and inventions are having their day in Cleveland. Through a new service recently established by the industrial development department of the Chamber of Commerce, inventors may submit descriptions of their devices. These are then listed in a letter which is sent to more than 2,000 manufacturers. The man with an idea only is also encouraged, although it is suggested that he protect himself if patents have not yet been applied for.

Several hundred people have already taken advantage of the plan and a number are now negotiating with Cleveland manufacturers. Those taking advantage of this patent and idea service are urged to submit full details with the first letter. Communications should be sent to Industrial Development Department, Chamber of Commerce, 1704 Terminal Tower, Cleveland, Ohio.

Los Angeles Company Protests Rate Cut

A petition has been filed with the California Railroad Commission by the Los Angeles Gas & Electric Corporation, asking a rehearing on the commission's recent order which reduced the rates of the power company approximately $1,350,000 for gas service, made permanent the temporary electric rates heretofore fixed by the commission for that company, and continued in effect reductions of approximately $750,000 a year for the service of electricity under those rates.

The company alleges in its petition that the commission erred in fixing the rate base at $60,704,000, and alleges that the fair value of its properties and business is not less than $95,767,321. The petition also alleges that the rates fixed by the commission will fail to yield the company a fair return upon the fair value of its property devoted to public use by an amount in excess of $2,000,000 a year.

New York Commission Confers With President

Members of the St. Lawrence Power Development Commission of New York called upon President Hoover and other government officials Dec. 4 to formulate plans for co-operation between the federal and state governments in the forthcoming negotiation with Canada on the development of power in the International Section of the St. Lawrence River. The delegation comprised Robert Murray Haig, the chairman, Julius Henry Cohen, Thomas F. Conway, Frederick M. Davenport and Samuel L. Fuller.

"We called upon the President to advise him of the progress made in our plans for development of power in the International Section of the St. Lawrence River," Mr. Haig said. "We are aware, of course, that the United States Government is endeavoring to arrive at an understanding with Canada for an improved waterway through the St. Lawrence.

"We told the President of our desire to avoid any possibility of conflict between the interests of the State of New York and those of the Federal Government. We believe that it is entirely possible to accomplish this result. This, of course, requires that the engineering plans for improvement of navigation and the engineering plans for the development of power by the State of New York through a board of power trustees shall be in all respects harmonious."

The commissioners conferred also with Undersecretary of State Joseph Cotton, F. E. Bonner, executive secretary of the Federal Power Commission

and with members of the Senate Committee on Foreign Affairs concerning questions involved in the development of the international section of the river, whether public or private. Mr. Haig pointed out that one of the difficult problems in connection with the project has been the number of vital basic points of engineering, law, economics and international relations which never have been determined authoritatively. He expressed the hope that the conferences of the commission in Washington will bring answer to some of these questions and that the formal groundwork may be laid for final determination of others. The state commission is planning to submit its report on the progress made in power development plans to Governor Franklin D. Roosevelt and the State Legislature on Jan. 15.

Connecticut Company Cuts Power Rates 20 Per Cent

A 20 per cent reduction in electricity rates, which will apply only to users of current in excess of twenty kilowatt-hours per month, was announced Dec. 8 by the Connecticut Light & Power Company, of which J. Henry Roraback, national Republican committeeman and state chairman, is president. The reduction will mean a saving of about $500,000 a year to some of the 146,000 customers of the company.

Mr. Roraback's control of the state was impaired for the first time in many years last month when J. Wilbur Cross, dean emeritus of the Yale Graduate School, was elected Governor.

4,000-Hp. Diesel to be Added to Tucson Plant

Plans covering additions to the generating station of the Tucson Gas, Electric Light & Power Company in Tucson, Ariz., have been announced by M. A. Pooler, vice-president and general manager. The work, which probably will be started early in 1931, will consist of an extension to the company's power plant building, the installation of a 4,000-hp. diesel engine, and the erection of a cooling tower. This program calls for an expenditure of $500,000.

Plan Exposition for Hoover Dam Completion

A bill providing for federal participation in an exposition to be held in Los Angeles in celebration of the completion of Hoover Dam in 1937, was introduced in the House at the opening session by Representative Swing of California. Representative Swing is co-author of the act authorizing the construction of the dam. According to the present plans, the entire project including an aqueduct for carrying water from the Colorado to Los Angeles and other Pacific Coast cities will be completed in 1937. Mr. Swing in his resolution makes federal aid conditional upon the raising of $3,000,000 for the exposition by Los Angeles and the other sections that will be benefited by the project. He proposes that foreign nations be invited to participate in the exposition.

COMING CONVENTIONS

American Society of Mechanical Engineers. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Annual meeting at the Mayflower Hotel, Washington, D. C., Jan. 15-17, 1931. Secretary, L. W. Wallace, 26 Jackson Pl., N.W., Washington, D. C.

American Institute of Electrical Engineers. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29, 1931. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

Engineering Institute of Canada. Annual meeting at the Windsor Hotel, Montreal, Que., Feb. 4-6, 1931. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

Obituary

JAMES BROWN HERRESHOFF, inventor and member of the famous Herreshoff family of designers and builders of America's cup defender yachts, died Dec. 5 at his home in Riverdale, N. Y. He was 96 years old. Born in Bristol, R. I., Mr. Herreshoff attended Brown University from 1853 to 1856 and was said to have been the oldest living graduate of that university. He early gained distinction as a chemist and mechanical engineer, and it was his invention of the flash coil boiler that gave the Herreshoff boat-building works at Bristol its start in the construction of steam vessels. He invented the first naphtha-driven motorcycle of the internal-combustion type in this country. He built the then astonishing vehicle in 1868 and chugged as fast as its four horsepower would permit through the streets of Bristol for four years until he ran it through a fence and abandoned it. Besides the boiler and internal-combustion engine, Mr. Herreshoff had to his credit many mechanical inventions, most of which related to ships and navigation.

Personals

DR. GEORGE OTIS SMITH, director of the United States Geological Survey since 1907, has been chosen by President Hoover to be chairman of the new Federal Power Commission. FRANK MCNINCH, of North Carolina, former mayor of Charlotte, was nominated for the remaining place on the committee. The three other members were nominated prior to the close of the last session of Congress. They were: FRANK B. WILLIAMSON, of Washington; COL. MARCEL GARSAUD, of Louisiana; and CLAUDE L. DRAPER, of Wyoming. The names are now before the Senate for confirmation.

JOHN COLLINS, JR., for the past several years vice-president and chief engineer of the United States Engineering Corporation, New York City, has recently been appointed chief engineer for Standard Management & Operating Corporation, San Francisco, Calif. Mr. Collins will be in charge of all construction and engineering enterprises performed by the management company for Pacific Public Service Company, its subsidiaries and for all clients of the company. He will also act in an advisory capacity regarding operations in properties now controlled by the company.

R. L. ROBINSON, for a number of years with the Griscom-Russell Company of New York City, has recently joined the Babcock & Wilcox Company as sales engineer.

F. D. NEWBURY, former manager of the power engineering department of the Westinghouse Electric & Manufacturing Company, has been appointed general manager of machinery engineering. Mr. Newbury has been with the engineering department since 1903, when he was placed in charge of the design of armature winding molds. In 1910 he was made assistant division engineer of the power division and one year later became engineer of this division. In 1920 he became manager of the power engineering department, which position he has continued to occupy until the present time. Succeeding MR. NEWBURY as manager of the power engineering department is R. A. MCCARTY. Previous to his promotion, Mr. McCarty had been division engineer in the department of which he is now the head.

ALBERT L. DEGGS, assistant superintendent of the northeastern division of the Lawrence (Mass.) Gas & Electric Company, DANIEL J. DONOGHUE, fireman in the company's South Lawrence Power Station, and ERNEST A. MCCOMISKEY, an operator at the company's Common Street Substation, were each presented recently with a lifesaving medal awarded by the National Safety Council for having successfully participated in the heroic saving of a human life. The presentation was made by the president of the company, FRED H. SARGENT.

Business Notes

DAYTON - DOWD COMPANY, Quincy, Ill., announces the appointment of J. B. Downey, 2944 North Second St., Phoenix, Ariz., as its sales representative for the State of Arizona.

ILLINOIS STOKER COMPANY, Alton, Ill., announces the establishment of an Eastern sales office at 30 Church St., New York City. Alex Girtanner will be in charge of this new office.

MISSOURI FIRE BRICK COMPANY, Vandalia, Mo., has just completed negotiations with the CHRISTY FIRE BRICK COMPANY, 620 South Second St., St. Louis, Mo., to take over the entire sale of its refractory materials. Under this arrangement the Christy company will devote its entire time to refractory problems, sales and service, enabling the Missouri company to devote its attention to the manufacture of refractory products, which will be placed on the market under the new brand names of "Christy-Hilumna," "Christy-Diamond" and "Christy-Audrain."

CENTRIFIX CORPORATION, Cleveland, Ohio, announces the appointment of the Wyman Engineering Sales Company, Chamber of Commerce Building, Cincinnati, Ohio, as its representative in that territory.

T. B. WOOD'S SONS COMPANY, Chambersburg, Pa., announces that it has entered into an agreement with the ALLIS - CHALMERS COMPANY of Milwaukee, Wis., whereby it has become the licensed manufacturer and distributor of Texrope drives in the territory known as District No. 3, which includes Pennsylvania, New York, New Jersey, Delaware, Maryland, Ohio, West Virginia, Virginia and North Carolina. The Wood's company is equipped to manufacture drives of standard and special construction and render engineering service in connection with them. It announces that a complete stock of ½- to 100-hp. drives is always on hand.

HEAT UTILITIES CORPORATION, New York City, has acquired all patents covering the Simplex pulverizer, which were formerly owned by the Furnace Engineering Company, a subsidiary of the International Combustion Engineering Corporation, and also patents and patent applications on the Uni-Flo pulverizer owned by Dr. Paul A. Hirsch and Warren C. Drake who is president of the company.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that its various plastic activities have been coordinated into one department known as the plastic department with R. E. Coleman as manager. The new department will be responsible for engineering, manufacturing and sales of plastics, which involve activities at the Pittsfield, Schenectady, Fort Wayne, Erie and Lynn plants of the company.

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How's Business?

WEEK BY WEEK business bumps along the rocky bottom of the valley looking forward grimly to the new year, expecting nothing more of this one, and getting it. The last months of depression are the toughest, but so is business sentiment by that time, and it becomes pretty hard to disappoint it any more. The general level of activity still fluctuates around the deadline, dipping again in the week ended Dec. 6 from 80.3 per cent of normal to 77.1 per cent. Basic industrial production continues to decline, along with freight movement, while retail trade rises, all according to the calendar, but hardly according to the requirements of a merry Christmas. What lies beyond the turn of the year becomes no easier to see clearly.—*The Business Week*, Dec. 17.

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Trade Catalogs

PUMPS—A new bulletin, No. 126, illustrating and describing open-shaft non-clogging pumps for sewage-disposal plants has just been issued by the Chicago Pump Company, 2336 Wolfram St., Chicago, Ill. Included in the bulletin is a short treatise on the necessity for sewage treatment works and the part a centrifugal pump plays in sewage handling and treatment. The pumps proper are discussed in detail and several pump installation suggestions are given.

ELECTRICAL EQUIPMENT — The Crouse-Hinds Company of Syracuse, N. Y., has issued a bulletin, No. 2213, on safety circuits for electrical equipment. It illustrates and describes safe circuits for portable electrical equipment and the devices used in their construction.

STEAM CONDITIONER—Bulletin 159 of the Railway Centrifix Company, 3029 Prospect Ave., Cleveland, Ohio, describes and illustrates the Centrifix steam conditioner for railway locomotives. Hook-ups with and without the balanced throttle combination are shown in the bulletin.

CONTROLLER VALVES—Many types of motor-operated automatic control valves for steam, water, air, gas and oil are described and illustrated in a new catalog, No. 2002, published by The Bristol Company, Waterbury, Conn. Temperature control instruments and recording instruments are also shown in the catalog.

MANAGEMENT — More than 400 articles and reports on problems of management, which have been prepared and published by the Policyholders Service Bureau of the Metropolitan Life Insurance Company, 1 Madison Ave., New York City, are listed in a new "Index of Economic Reports" just issued by this company. Included in this revised edition of the index are many new studies on production, marketing, sales management, personnel, accounting and finance, and the like.

FLOORING—Engineering data on continuous, open-work, steel flooring for use in power and industrial plants is given in a recent publication of the Irving Iron Works Company, Long Island City, N. Y.

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Fuel Prices

FUEL OIL

New York—Dec. 11, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Dec. 5, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.47 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 3.901c.@4.026c. per gal.; 38@40 deg., distillate, 4.651c.@4.776c. per gal.

Pittsburgh—Dec. 4, f.o.b. local refinery, 34@36 deg., fuel oil, 3.37½c.@3.75c. per gol.; 36@40 deg., 3.5c.@3.75c.

Philadelphia—Dec. 3, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.26@$1.31 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Dec. 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Dec. 3, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 80c.@90c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—Dec. 8, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

Dallas—Dec. 6, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @$2.25
Pool 10, hr.gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.50 @ 1.50
Harlan, Ky., slack	Chicago	.50 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.10 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.70
W. Ky., mine-run	Louisville	1.00 @ 1.35
W. Ky., slack	Louisville	.15 @ .20
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	.75 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.35 @ .50

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15 @ 1.50

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Pasadena—City awarded contract for steam generating equipment for municipal light plant to C. C. Moore & Co., 108 West 6th St., San Francisco, $141,555.

Calif., San Mateo—San Mateo Union High School District, plans an election to vote $300,000 bonds for school additions, including boiler room units, etc.

Ind., Goshen—City awarded contract for the construction of a new electric generating plant to Rieth-Riley Construction Co. $27,464.

Ind., Greenfield—City is having plans prepared for addition to light plant including switchboard, generator and engines. Estimated cost $55,000. O. P. Gordon, is engineer.

Ind., Indianapolis—U. S. Veterans Bureau, Washington, D. C., will receive bids until Jan. 2 for the construction of a hospital including ice making and refrigeration plant, etc. at West Riverside Dr. and 20th St. here. Estimated cost $500,000.

Mass., Cambridge (Boston P. O.) — Massachusetts Institute of Technology, K. T. Compton, Pres., Charles River Rd., will receive bids about Jan. 1 for the construction of a 5 story, 50 x 300 ft. physics and chemistry laboratory. Estimated cost $800,000. Coolidge & Carlson, 89 State St., Boston, are architects. C. T. Main, Inc., 201 Devonshire St., Boston, are engineers.

Mass., Clinton—Town, T. Fallon, plans the construction of a pumping station and pipe line at Metropolitan Reservoir. Estimated cost $60,000. Engineer not selected.

Mass., Martha's Vineyard—Cape & Vineyard Electric Co., P. H. House, Supt., Vineyard Haven, plans addition to power plant. Estimated cost $50,000. Private plans.

Mass., Medford — Malden Electric Co., 157 Pleasant St., is having plans prepared for the construction of a sub-station on Salem St. Estimated to exceed $40,000. C. H. Tenney Co., 38 Chauncy St., Boston, are engineers.

Mass., Westboro—City awarded contract for the construction of a pumping station at Westboro State Hospital to T. A. Cassidy, 54 Boylston St., Fitchburg. Estimated cost $25,000.

Mich., Detroit—Detroit Edison Co., 2000 Second Blvd., is having plans prepared for the construction of coal unloading dock to include coal handling and unloading equipment at Connors Creek power station on Detroit River. Private plans.

Mich., Detroit — University of Detroit, Livernois and Six Mile Rd., awarded contract for a 3 story, 150 x 175 ft. high school, including power plant, etc., on Cambridge Ave. to Otto Misch Co., 159 East Columbia St. Estimated cost $650,000.

Mich., Monroe—St. Mary Academy, Servants of Immaculate Heart of Mary, is having plans prepared for the construction of a 2 and 3 story convent including power plant, etc., on West Elm Ave. Estimated cost $250,000. D. A. Bohlen & Sons, 1001 Majestic Bldg., Indianapolis, Ind., are architects.

Mich., Lansing — City National Bank, is having plans prepared for the construction of a 14 story bank and office building including steam heating and ventilation systems, boilers, elevators, etc. at Washington and Michigan Aves. Estimated cost $600,000. L. and K. Black, Capital Savings & Loan Bldg., are architects.

Minn., St. Paul—City, M. Rosen, Comr. of Public Works, City Hall, plans the construction of a 3 or 4 story workhouse, including steam heating system, etc., near Como Park. Estimated cost $600,000. C. A. Bassford, City Hall, is architect.

Mo., Bagnell—Union Electric Light & Power Co., 12th and Locust Sts., St. Louis, awarded contract for steel wire to Indiana Steel Co. and J. A. Roebling Sons & Co., Railway Exchange Bldg., St. Louis $30,000 and for 4,000 tons of fabricated steel to McClintic & Marshall Co., 1010 Pine St., St. Louis, for use in Bagnell Dam on the Osage River. Owner now taking bids on transmission line, insulators, etc. $300,000.

Neb., Hawthorne—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 26 for a group of buildings including 79 x 99 ft. building for cooling and storage purposes, heating and boiler plants, mechanical equipment, etc., at Naval Ammunition Depot here. Estimated cost $285,000.

N. J., Jersey City—Springarn Realty Co., J. Springarn, Pres., 590 Summit Ave., will receive new bids about Jan. 15 for the construction of a 9 story office and stores building including steam heating and ventilation systems, boilers, elevators, etc. at Newark and Oakland Aves. Estimated cost $750,000. W. Newmann, 26 Journal Sq., is architect and engineer.

N. J., Skillman—Dept. of Institutions & Agencies, Trenton, awarded contract for electrical work for power house at Epileptic Village here to Mitchell & Co., 1337 McFerran St., Philadelphia, Pa. $18,323.

N. Y. Brooklyn—Dept. of Water, Gas & Electricity, Municipal Bldg., New York, will soon receive bids for the construction of a 2 story, 59 x 103 ft. pumping station at Neptune Ave. and Bay View St. Estimated cost $150,000. D. M. Metcalfe, Huntington, L. I., is engineer.

N. Y., New York—Chase National Bank, 18 Pine St., is having sketches made for the construction of a 60 story bank and office building. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects. Maturity about February.

N. Y., Poughkeepsie — Dept. of Mental Hygiene, State Office Bldg., Albany, received lowest bid for repairs to boiler house at Hudson River State Hospital here from Miller & Gaynor Co., Overocker Rd., Poughkeepsie.

O., East Cleveland—Huron Road Hospital, E. P. Disbro, 8811 Euclid Ave., is having plans prepared for the construction of a 6 story hospital including steam heating system, etc. at Belmore and Terrace Roads. Estimated cost $1,000,000. G. S. Rider Co., Marshall Bldg., Cleveland, are architects and engineers.

Okla., Cushing—City voted $300,000 bonds for the construction of a 3,000 hp. electric light plant.

Pa., Oakmont—Duquesne Light Co., 435 6th Ave., Pittsburgh, is having preliminary plans prepared for the construction of a sub-station at Hulton Rd. and Allegheny Ave. here. Byllesby Engineering & Management Corp., 435 6th Ave., Pittsburgh, are engineers.

Pa., Pittsburgh—Bd. of Education, J. A. Bonar, Supt. Bldg., Administration Bldg., will soon award contract for the construction of a 4 story school including steam heating and ventilation systems, boilers, stokers, temperature regulation and unit heaters, etc. at Butler and 40th Sts. Estimated cost $1,250,000. Schwab, Palmgreen & Merrick, 1707 Koppers Bldg., are architects. C. L. Woolridge, Inc., Fulton Bldg., are engineers.

Tex., Yoakum—City plans the construction of waterworks and distribution systems to include, reservoir, large pumping unit, etc., also electric light plant consisting of large dynamo or power unit, extensions to lines, etc. Estimated cost $300,000 and $200,000 respectively. Montgomery & Ward, Wichita Falls, are tentative engineers.

Wash., Seattle—Bureau of Yards & Docks, Navy Dept., Washington, D. C., received lowest bid for the construction of a boiler plant at Air Station here from Western Construction Co., Seaboard Bldg., $19,983.

Wis., Milwaukee—Owner c/o M. Tullgren & Sons Co., 20 Prospect Ave., Archts., will soon award contract for the construction of a 9 story apartment building including steam heating and refrigeration systems, elevators, etc., on Koul Pl.

Ont., Ottawa—City, N. H. H. Lett, City Hall, Clk., will receive bids until Dec. 23 for superstructure of water purification plant on Lemieux Island also until Jan. 6 for equipment including filters and chlorination equipment. Estimated total cost $1,815,000. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers. A. F. Macallum, City Hall, is city engineer.

Ont., Toronto—Dept. of Public Works, East Block, Parliament Buildings, plans a 6 story addition to government office building including steam heating system, etc. Estimated cost $1,000,000. Private plans.

Equipment Wanted

Engine—Gridley, Calif.—City plans the installation of a Diesel engine in municipal electric light plant.

Pumps, etc.—New Orleans, La.—Sewerage & Water Board, G. G. Earl, Gen. Supt., will receive bids until Feb. 4, for Cont. 119-D motors and accessories for drainage station 6 and 7, Cont. 208-S vertical trash pumps, etc. for drainage station 2, 6 and 7.

Pumps, etc.—Caledonia, Ont.—Town plans to purchase pumps, etc., for proposed waterworks system. Estimated cost $60,000.

Pumps, etc.—New Lisbon, N. J.—Burlington County Freeholders, A. Adams, Clk., Mount Holly, will receive bids until Dec. 26 for electrically operated submerged type turbine pumps, etc. for proposed waterworks improvements.

Industrial Projects

Calif., Santa Ana—Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa., is having preliminary surveys made for the construction of a sheet glass manufacturing plant here. Estimated cost to exceed $1,000,000. Stone & Webster Engineering Co., 120 Broadway, New York, N. Y., are engineers.

Conn., Hartford—New England Electric Co., 103 Allyn St., is receiving bids for the construction of a storage and service building at Spring and Church St. Ext. Estimated cost $75,000 to $100,000. Westcott & Mapes, 139 Orange St., New Haven, are architects.

Kan., Kansas City—Great Lakes Pipe Line Co., Ponca City, Okla., awarded contract for the construction of a 1 story, 50 x 74 ft. pump house and 24 x 50 ft. boiler house here, also at Bethany and Osborne, Mo., to D. C. Bass & Sons, Enid. Estimated cost $60,000.

Mass., West Springfield—Springfield Wire & Tinsel Co., 68 Taylor St., Springfield, awarded contract for the construction of a factory on Taylor St., to L. S. Wood, 14 Stockbridge St., Springfield. Estimated cost $40,000.

N. J., East Brunswick—Anheuser-Busch, Inc., c/o A. A. Busch, Pres., 721 Pestalozzi St., St. Louis, Mo., acquired a site and plans the construction of a 7 or 8 story yeast plant, 100,000 lb. daily capacity to include power plant, machine shop, garage, etc. Estimated cost $2,000,000.

N. Y., Syracuse—Solvay Process Co., Milton Ave., will build a dock on Lake Onondaga, hoisting and stevedoring equipment, plant and storage alterations. Estimated cost $200,000. Work will be done by day labor and separate contracts.

O., Cleveland—Yoder Co., C. M. Yoder, Pres., 5500 Walworth Ave., manufacturers of overhead door machinery, will soon award contract for the construction of a 1 and 2 story factory at West 55th St. and Walworth Ave. Estimated cost $200,000. W. H. Hatch, 559 Hippodrome Bldg., is architect.

O., Lorain — National Stove Works, subsidiary of American Stove Co., J. R. Haley, Plant Mgr., plans the construction of a 1 story, 125 x 125 ft. enameling plant. Estimated cost $250,000. Carter-Richards Co., Engineers Bldg., Cleveland, are architects and engineers. Press equipment will be required.

Okla., Okmulgee—Great Lakes Pipe Line Co., Ponca City is having plans prepared for the construction of a gasoline pumping station; also thirty miles of pipe line at Okmulgee refinery here. Estimated cost $160,000 and $100,000 respectively. F. E. Richardson, Tulsa, is engineer.

Okla., Ponca City—Great Lakes Pipe Line Co., awarded contract for the construction of seven pumping stations and boiler houses to A. G. McKee & Co., 2422 Euclid Ave., Cleveland, O. Estimated cost $650,000.

Pa., Johnstown—Bethlehem Steel Co., Bethlehem, plans extensions and improvements to plant here. Estimated cost to exceed $3,000,000. Work will be done by day labor and separate contracts.

Pa., Portage — Century Ribbon Mills, 80 Madison Ave., New York, N. Y., plans the construction of a 1 story silk mill here. Architect not selected.

Texas—Phillips Petroleum Co., Bartlesville, Okla., awarded contract for supply of 21 sets of step-up gears for seven booster stations in connection with 760 mi. gasoline pipe line being constructed from Borger, Tex., to St. Louis, Mo., by Phillips Pipe Line Co., subsidiary of Phillips Petroleum Co., to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

China, South Manchuria, Dairen — International General Electric Co., 120 Broadway, New York and Tokyo Electric Co., Tokyo, Japan, plan the construction of an electric lamp manufacturing plant here. Estimated cost $1,500,000.